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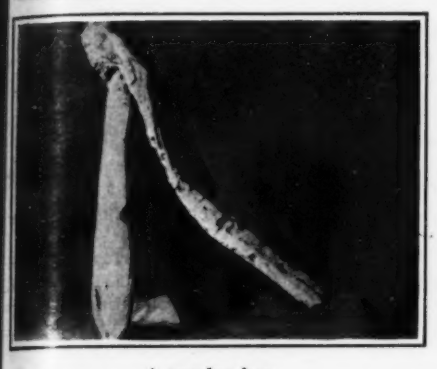
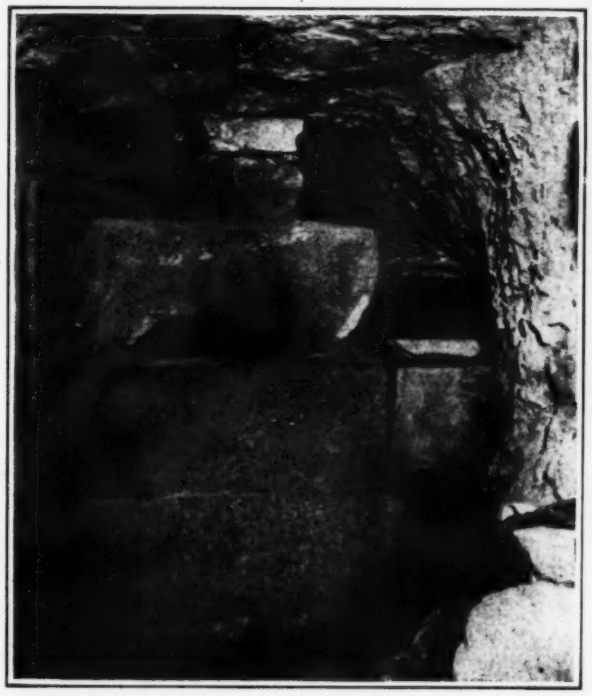


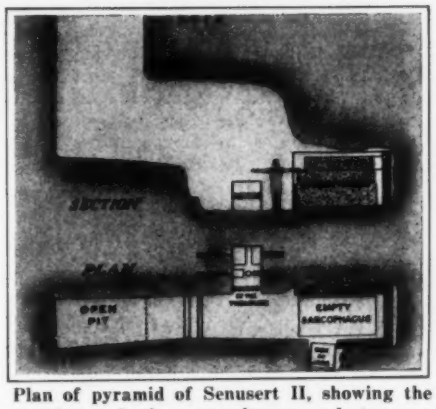
A wooden hoe.



The granite sarcophagus with broken lid, plundered by those who took everything from it, but did not find the treasure in a recess close to it. On right, box of jars.

Rollers for moving stones.

Obsidian jars for ointments, with gold mounts.



Plan of pyramid of Senusert II, showing the positions of the sarcophagus and treasure recess which yielded the remarkable finds.

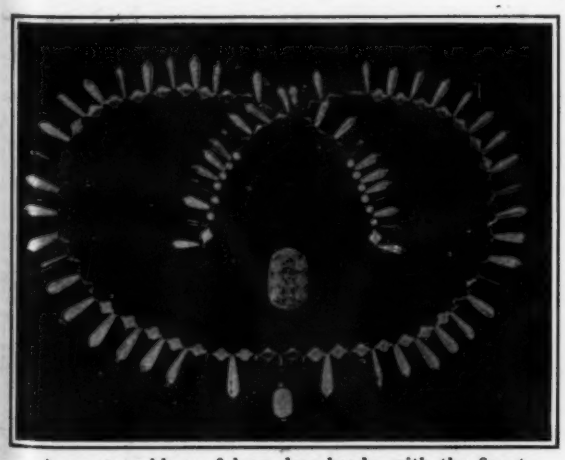
Limestone lamps of pyramid builders.

The pyramid in which the treasure of Lahun was found.

Live ducks.

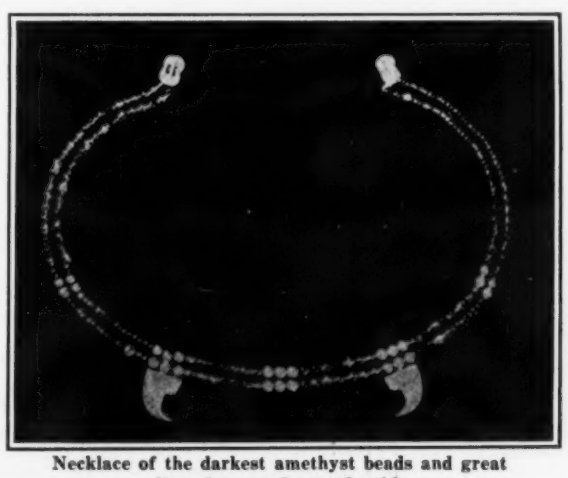
Dead ducks.

Mason's mallets. (Same kind still used.)



A great necklace of long drop-beads, with the finest Scarab known.

Silver mirror with Obsidian handle.



Necklace of the darkest amethyst beads and great lion claw pendants of gold.

THE BEAUTIFUL ART TREASURES OF LAHUN, OVER THREE THOUSAND YEARS OLD, RECENTLY FOUND IN THE PYRAMID OF SENUSERT II.—[See page 265.]

From the *Illustrated London News*.

Electro-Culture*

A Resumé of the Literature and Summary of Facts from Scattered Sources

THE scientific literature of the last ten years has contained frequent references to the art of increasing plant growth and yield by the application of electric stimuli of certain kinds, an art most commonly designated as electro-culture. The material given, however, represents very little experimental work in proportion to its volume, consisting in the main of more or less complete historical reviews concluded by a few paragraphs describing some recent investigation. The effect upon a reader desiring to become acquainted with the work done within a reasonable length of time is irritating, to say the least. In view of the growing interest in intensive methods of agriculture, and also in methods of filling in the valleys in the load curves of central stations, there is reason to expect a much more exhaustive investigation of this subject in the not remote future. For this reason it has seemed desirable to collect the facts from the scattered sources, and attempt to arrange them in a form more convenient for use, that is, from the point of view of the invader of the province rather than the historian.

It has been found that the experiments of the past fall naturally into five classes, differing principally in the method of application of electrical energy. These methods are:

I. Illumination by electric light.

II. Conduction of atmospheric electricity from an elevated collector to an electrode in the soil, or to discharge points above the plants.

III. Constituting the soil the electrolyte of a voltaic cell by burying in it two plates of dissimilar metal connected by a conductor.

IV. Passing current from an external source through the soil between electrodes buried therein.

V. Production of a silent or glow discharge through the air from overhead antennae to the soil.

These methods will be taken up in the order given, which is approximately that of their importance.

METHOD I.

Illumination by Electric Light.

There seems to have been relatively little work done upon the effect of illuminating plants by artificial or electric light. In 1861 "Herve" Mangon found that electric light influences the formation of chlorophyl in a way similar to that of sunlight. That the absorption and assimilation of carbon dioxide occurred as usual under the electric arc was shown by Prèllieux eight years later.

In 1880 Wilhelm Siemens confirmed these observations, but found that under certain conditions injurious effects were obtained and hence he used an opalescent glass shade over the light.

These facts were further confirmed by Schraier in 1881, and by Bailey, Cornell University, in 1891. Bonnier in 1892, and Couchet in 1901, studied the structure alteration in plants and the leaf growth in relation to the electric light.

Since 1891 this line of attack has been neglected, probably because of the attention attracted by the work of Lemström, and the success of his method.

Dorsey, however, in 1914, mentions the treatment of hot-house radishes and lettuce for three hours each day beginning at sunset, with red light from a 100-watt lamp, and with blue light from a Cooper-Hewitt lamp. The lettuce was affected favorably, the radishes unfavorably.

METHOD II.

Condition of atmospheric electricity from an elevated collector to an electrode in the soil, or to discharge points above the plants.

Among the earliest attempts to apply atmospheric electricity to plant culture appears to have been that of Abbe Bertholon, in 1783. He called his apparatus the electro-vegetometer. It consisted of a number of metal points similar to a lightning rod, supported at a considerable elevation, and connected by a conductor to an iron bar furnished with discharge points which hung down just over the plants treated. The whole apparatus was insulated by wooden supports. The Abbe stated that the use of this arrangement always produced an increase in the fertility, vigor, and growth of the plants.

Later, 1879, Grandeau and his pupil LeClerc showed by careful comparative measurements, analyses, etc., that protection of plants from atmospheric electricity by enclosure in wire cages often retards the growth over 50 per cent. But Naudlin repeated his experiment a little later with results diametrically opposite. The more recent experience of Pinot de Moira appears to substantially agree with that of Grandeau.

A modification of Bertholon's method called the geomagnetifére system has been quite commonly used in France. This consists of an elevated conductor connected to wires running through the soil under the plants to be influenced.

Berthelot carried on considerable work at Meudon in France. He found that the growth of plants on the top of a 28-meter tower was greater than at the foot.

Lieutenant Basty experimented with metal rods terminating in a ball of non-oxidizable metal at the lower end which was buried in the ground as deeply as the roots of the plant were likely to penetrate and projected from 2½ feet and 6½ feet above the surface, depending upon the plant treated. The first height was used for strawberries. He claimed that beneficial results were noted about each rod for a radius equal to half the height.

METHOD III.

Constituting the soil the electrolyte of a voltaic cell by burying in it two plates of dissimilar metals connected by a conductor.

Speschnew in Russia obtained marked results from plates of different metals buried in the ground connected by wire.

More recently, 1906, Rawson and Le Baron have used the same method in greenhouses. Plates of copper and zinc were sunk at opposite ends of lettuce beds and gave a potential difference of 0.5 volt and current of from 0.4 to 15 milliamperes. The lettuce thus treated was ready for market a week sooner than that not treated.

Priestly tried the method of Speschnew, using plates of copper and zinc between which beans were planted. The plants treated appeared two days earlier, developed more rapidly, and the average size and weight of the mature beans was about a third greater. Some other qualitative experiments were inconclusive. The current in very damp soil was 12 milliamperes between plates of 200 square inches, 4 feet apart.

Newman, however, states that the results of a dozen experiments indicated no effect whatever, and that the reports of others have been in confirmation of this fact.

METHOD IV.

Passing current from an external source through the soil between electrodes buried therein.

This method of plant stimulation has been the source of numerous conflicting reports, and its applicability seems still to be in doubt. A number of investigators have found that it increases the rate and proportion of germination.

E. H. Cook states that this is the only effect that he was certain was produced by currents of 100 milliamperes at 20 volts.

Kinney in 1898 and Ahlfvengren in 1899, confirmed his results. The former considered 3 volts the optimum, but the latter believed this to vary for different plants, and, under different conditions, for the same plant. Lewenherz's conclusions also agreed with the above, but he considered also that the direction in which the current traversed the seed was of importance.

Kövessi, 1912, on the other hand, as a result of over 1,100 pot tests, came to the conclusion that direct currents through the soil are without exception harmful both to germination and later growth. Schneckenberg, commenting upon this paper, remarked that he ought to have known this fact from a knowledge of the simple laws of electro-chemistry and endosmosis before performing the 1,100 experiments, but goes on to point out that Kövessi's statement should read "horizontal direct currents through the soil" and must not be extended to cover any other type of electrical treatment. Kövessi does not state what strength of current he employed.

Gerlach and Erlwein, 1910, describe experiments with low potential direct current, 6 volts, 0.2 to 0.4 ampere, at Bromberg, upon an area of 914 square feet planted to barley and cabbages. The treatment was continuous night and day until harvest. No beneficial effect was obtained.

Peaslee, 1910, using direct current in greenhouse experiments on the germination and rate of growth of seedings, such as cauliflower, cabbage, beets, etc., experienced failure until he lowered his current density and adopted carbon electrodes, which, unlike some metals, do not react with the soil to form deleterious salts. He obtained the most favorable results at a power consumption of between 0.5 and 0.6 watt per cubit foot, which gave increased fertility of seed, more rapid and vigorous development, and increased size of plant, especially of the root. In the case of a cauliflower, the advantage in respect to growth was nearly 150 per cent. Radishes carried through to a marketable size had a root growth 403 per cent, and a top growth 117 per cent greater than the control[1] plants.

Similar tests with alternating current were consistently negative again until the watts per cubit foot were reduced to 0.0114 (current = 0.000034 amperes per square inch when an increased fertility of 50 per cent and an increased growth of 32 per cent was obtained.

Dorsey, 1913, tried some greenhouse experiments, using direct current (1.5 volts and 0.0003 to 0.07 amperes, and 3 to 8 volts and 0.0007 to 0.05 ampere) and also 60-cycle alternating current, 110 and 220 volts between carbon electrodes. The results were bad in both cases. The temperature of the treated beds was a degree higher than the controls.

It is evident that the investigation of this type of electric treatment has been entirely insufficient to lead to any trustworthy conclusions. The controlling factors have scarcely been indicated as yet.

METHOD V.

Production of a silent or glow discharge through the air from overhead antennae to the soil.

The stimulation of crops by a discharge of electricity through the air to the soil seems to be the method best founded upon theory and most promising in practice.

Prof. Lemström of Helsingfors University, Finland, first remarked upon the fact that the extraordinarily rapid and fruitful growth of such vegetation as survives the frosts in the Arctic and sub-Arctic regions cannot be accounted for, as has been suggested, by the long hours of daylight. It has been proved beyond doubt that there exist in the atmosphere of these high latitudes much stronger currents passing to the earth than is the case further south. These are evidenced by their luminescent effects, such as the aurora. A great proportion of the vegetation, especially that peculiar to northern regions, is equipped with pointed leaves, etc., which are especially adapted to electrical discharge. Moreover, in studying sections of fir trees, Lemström found a periodicity in the occurrence of especially large growth which is the same as that of the occurrence of sun spots and auroras, i. e., every ten or eleven years.

He suspected that the electrical influence played a part hitherto overlooked in the growth of vegetation in other parts of the world. With this in view, he tried to reduplicate the conditions of the Arctic by producing a similar electrical tension in the atmosphere. He applied a positive potential from an influence machine, of which the negative was grounded, to a wire between suspended above the plants, producing a silent discharge to the earth.

Lemström extended his researches to different farms in Finland and, in later years, to other countries. The procedure was tested under his supervision at Durham College, England; in Burgundy, near Breslau in Germany, and at Atvadaberg. His book contains full details as to the extent, circumstances, and results of all these experiments. As a result of his experience he concludes that the minimum increase in yield for all crops under the proper conditions should be about 45 per cent. For certain crops it may rise as high as 100 per cent. Improvement occurs whether the network be charged positively or negatively to the soil, but better results were obtained in the former case. The effect is not apparent alone in the quantity, but an improvement of quality, and a shortening of the period of growth, sometimes by 50 per cent, is general. Analyses are given to indicate that in the case of grain there is an increase in the proteid content. Lemström points out that lack of uniformity in cultivation, nature of soil, and fertilization between the experimental and control plots often leads to erroneous conclusions. The better cultivated and fertilized a field is, the larger the percentage increase in yield due to electro-culture.

Lemström's procedure suffered from a great disadvantage. His influence machine was quite inadequate for the purpose, hence his overhead wires could not be hung more than 16 inches above the plants, which interfered with economical cultivation of the soil.

At Gloucester, experiments with a somewhat more powerful machine, enabling the elevation of the wires to 5 feet above the ground, gave results with various crops as follows:

Beets, 33 per cent increase; carrots, 50 per cent in-

* *General Electric Review.*

[1] The expressions "control," "control plants," etc., are used in this article to signify comparative experiments carried on simultaneously under the same conditions, but without electrical stimulation.

crease; turnips, increase not quantitatively measured.

The beets raised under electrification gave on analysis about 14 per cent more sugar than the control crop.

This increase in sugar content has been confirmed by almost every investigator, irrespective of whether his results were favorable to the process in other ways.

In 1904, Newman performed some similar tests with a small Wimshurst machine driven by an oil engine, operating upon 15 greenhouses, and upon an area in the open amounting to about 1,000 square yards, including control plots. The wires were strung about 16 inches above the plant tops, and were furnished with downward directed points of fine wire for discharge points.

The treatment was applied for a period of 108 days, 9.5 hours daily, the first half of the time mainly by day, the last half by night. The results from the electrified plants were as follows:

Cucumbers, 17 per cent increase; strawberries, 5-year plants, 36 per cent increase; strawberries, 1-year plants, 80 per cent increase, and produced more runners; broad beans, 15 per cent decrease, ripened 5 days sooner; cabbages (spring) mature 10 days sooner; celery, 2 per cent increase; tomatoes, no effect.

The cucumbers were all affected by a bacterial disease about the middle of their growth, and this made much greater headway on the non-electrified plants. Aside from the troubles with the influence machine and oil engine, which were rather inadequate, the installation required no attention except for the clearing away of cobwebs and stray shoots, etc., from the network.

This work was continued on a larger scale, Newman working in conjunction with Sir Oliver Lodge. The latter overcame several of the inherent difficulties of the process by the invention of a mercury arc rectifier supplying a 100,000-volt direct current. The new installation consisted of an oil engine and dynamo producing 3 amperes, at 220 volts, which was transferred by an induction coil and then rectified.

This higher potential made it possible to raise the conducting network to 16 feet from the ground, thus permitting of easy cultivation without lessening the beneficial effect of the current.

Preliminary experiments upon wheat at Gloucester having been very favorable, Newman subjected 11 acres to treatment. The overhead network consisted of stout telegraph wires mounted upon poles in rows 102 yards apart, the distance between successive poles being 71 yards, and thin galvanized wires stretched 12 yards apart crosswise to act as discharge wires. A difference in the rate of growth was noticeable very early, and at harvesting the straw averaged from 4 to 8 inches taller, and the Canadian wheat ripened 3 or 4 days sooner. The yields were 39 per cent better for Canadian wheat, and 29 per cent better for English. Further the electrified wheat sold for 7.5 per cent better price on account of its superior quality.

Breslauer, who has written a critical review of the subject up to 1910, and kept in close touch with the progress of the work in Germany, tells (1909) of the results obtained at Halle by Kühn, and at Holstein, Neumark, and Westpreussen.

At Halle experiments were made under various conditions of fertilization and irrigation upon a total area of about 14 acres, besides the control areas. This field installation was also raised to 16½ feet above the ground. The good effect upon rye was already noticeable in June. It was observed here especially that when the wind blows the effects of the treatment are felt from 10 to 16 feet and sometimes 50 feet beyond the limits of the field experimented upon, and whenever the control fields are adjacent, reduces by so much the apparent improvement due to electrification. This wind effect was also noted in work at Holstein.

After the completion of these experiments, a year later, 1910, Prof. Kühn, the German "Nestor of agriculture," under whose immediate supervision they were conducted, was not enthusiastic as to the results. He stated that little was to be expected from the English procedure, as the advantage apparent during growth did not appear in the yield. His control fields of grass and grain gave the better results. Only fodder and sugar beets were bettered, the latter indeed having an increased sugar content. Clover and cabbages gave uncertain results. He considered that the cost would demand at least a 15 per cent increase in yield.

Breslauer concludes that the investigations already made show that the process and apparatus is entirely practicable. He estimates the cost of an equipment for 61.8 acres as follows:

Generating apparatus	$595.00
Field equipment	595.00
Power consumption, 5 kilowatt-hours per day (at 5 cents) = 25 cents, for season, 150 days =	37.50
Interest on $1,190.00 at 5 per cent	$ 59.50
Sinking fund at 7 per cent	83.30
Repairs at 2 per cent	23.80
Power	37.50
Labor (1 man 2 hours a day)	47.60
Total	$251.70

Medium to poor yield from wheat: 2,000 pounds per acre:

For 61.8 acres	$2,380.00
Thirty per cent increase	714.00

Profit $714.05—$251.70 = $462.30.

Ordinary profit from 61.8 acres = $71.40.

In a later contribution Breslauer describes the measurement of current and power consumption by typical installations at Hoppegarten.

A movable coil ammeter of great sensitiveness was inserted in the ground wire. The order of magnitude of the voltage was determined by measuring the length of spark in the air, it being known that between balls of 25 millimeters diameter it requires about 3,000 volts per millimeter to produce a spark.

In dry, and not extremely hot weather, with an east wind, the voltage averaging about 65,000 volts, he estimates that, allowing for a certain inequality of distribution, the current for every 10 square feet is about 0.43×10^{-3} milliamperes.

Hence the energy consumption is about $0.26.10^{-3}$ amperes × 65,000 volts = 17 watts = $0.28.10^{-3}$ watts per 10 square feet.

This is from 1,000 to 10,000 times the transfer of electric energy occurring naturally during a year, as estimated by Kähler.

Gerlach and Erlwein give an account of agricultural experiments upon the Kaiser Wilhelm Institute of Agrisulture Experimental Grounds at Mocheln for which the equipment was supplied by the firm of Siemens & Halske.

The electrical treatments included high tension static electricity, making the net positive in some cases, and negative in others, and high tension, single-phase alternating current.

The network consisted of a heavy galvanized wire supported on well insulated poles around the outside of the field, and suspended from this, across the field, thin galvanized iron wires at a height of 20 feet.

The electrical equipment consisted of a 4 horse-power alcohol motor belted to a direct-current dynamo, and a transformer. The two influence machines were run by direct-current motors.

The experimental plots comprised an area of 800 square yards besides control plots of one-half this area located at a distance of 330 feet. The plots were treated with various kinds of fertilizer, some were irrigated and others not.

The alternating-current antenne averaged a voltage of about 20,000, the static antenne 30,000 volts. The power consumption for the former was about 770 volt-amperes, for the latter about 30 watts. The irradiation was begun after planting, and continued 45 days continuously day and night. No difference was apparent between the electrified and untreated plants, though there was a considerable difference between the watered and unwatered, and between those differently fertilized. Mention is made of the occurrence of a drought. The harvest, occurring 120 days after sowing, showed practically identical yields for treated and untreated plants, with slight evidence of injury by the alternating current.

Höstermann, 1910, used a network of telephone wires from 6½ to 8 feet above the ground and 13 feet apart, and obtained his current from the atmosphere by means of a steel cable 820 feet long, supported by a balloon or by several kites. He estimated, having an instrument reading to only 5 volts, from other measurements, that he got a potential of about 25,000 volts. This method gave him the best results of any, increasing the yield on various crops from 15 to 40 per cent. He found that the atmospheric potential gradient varied with the season, the time of day, the temperature, and the weather, reaching maxima from December to February, shortly after sunrise and just before and during dusk, at low temperatures, and during fog, snow, hail or rain, and especially during thunderstorms.

The conditions under which treatment is applied are important, it being very essential that there should be moisture in the air as irradiation during dry and sunny weather often results injuriously to the plants. The most favorable times for treatment correspond with those of maximum potential gradient, i. e., very early morning and evening, especially during a fog. He points out that the climate of England is especially adapted, and should give good results, especially as the treatment seems to compensate in part for lack of sunshine.

Exclusion of the influence of atmospheric electricity reduced the yield nearly 15 per cent.

Höstermann, also using high potential pulsating direct current from a dynamo machine and transformer found that extended treatment was of little, or injurious effect, but claimed more moderate application increased the yield in some cases as much as 25 per cent.

Stahl, 1911, claims he was able, using electrical stimulation, to bring a crop of corn to maturity after the winter wheat was reaped on July 25th. He used a direct-current potential of about 250,000 volts (600 cycles) stepped up from a 60-cycle, 110-volt line and rectified mechanically. The wires were mounted 8 feet from the ground, and 2 to 3 feet apart. The treatment was applied to 1 acre morning and evening, and the electric bills averaged $2 to $3 per month. A variety of vegetables were treated. All matured much more quickly and resisted drought better. Only qualitative results are given.

Gloede used the treatment in growing flowers and found greatly increased vigor as well as resistance to harmful fungi. In a small outdoor plot 20 feet square he ripened 362 muskmelons from seed in less than 9 weeks, and the fruit was noticeably sweeter than usual.

An installation near Prague, designed by Breslauer, operated upon an area of 89 acres by means of a network of iron wire supported by porcelain insulators upon wooden poles at intervals of 328 feet apart, across which was stretched a network of 0.008-inch wire at a height of 13 feet above the ground. Direct current at 120 volts, 2 amperes, was supplied by means of a mercury interrupter, a transformer, producing 100,000 volts, and a rectifier. The network was always made positive, and the treatment applied only a few hours each day, being always discontinued in case of rain, which caused leakage, and of great heat, under which latter condition the current is injurious. In spite of an unusually dry season yields in some cases double that of the control plots were claimed. Details as to sort of crop and actual yields are not given.

Basty, experimenting on a regimental garden in France claimed good results.

Dorsey applied to small greenhouse beds for an hour night and morning, daily, alternating current of 200,000 cycles frequency, at 10,000 volts from a Tesla machine and transformer, consuming about 130 watts. He used a network of 0.01-inch wire at a height of 15 inches above the bed. He found by weighing representative plants a marked gain amounting to 75 per cent for lettuce. This method gave better results than illumination or earth currents.

He next applied a silent discharge by means of a network of 0.08-inch copper wire, 9 feet above the ground, 15 feet apart on insulators designed for 60,000 volts, to over an acre of garden, using 10,000 to 20,000 volts at 30,000 cycles for 5 hours daily for 2 months and 50,000 volts for 1 month. Interruption of service makes the results only qualitative in value. Almost all of the irradiated plants, including radishes, lettuce, beets, cabbages, cucumbers, turnips, melons, tomatoes and parsnips, gave a better growth than on the untreated acre. Beans and peas were affected slightly, but all the other plants matured at least 2 weeks earlier than the control plants. Tobacco showed a 20 per cent gain.

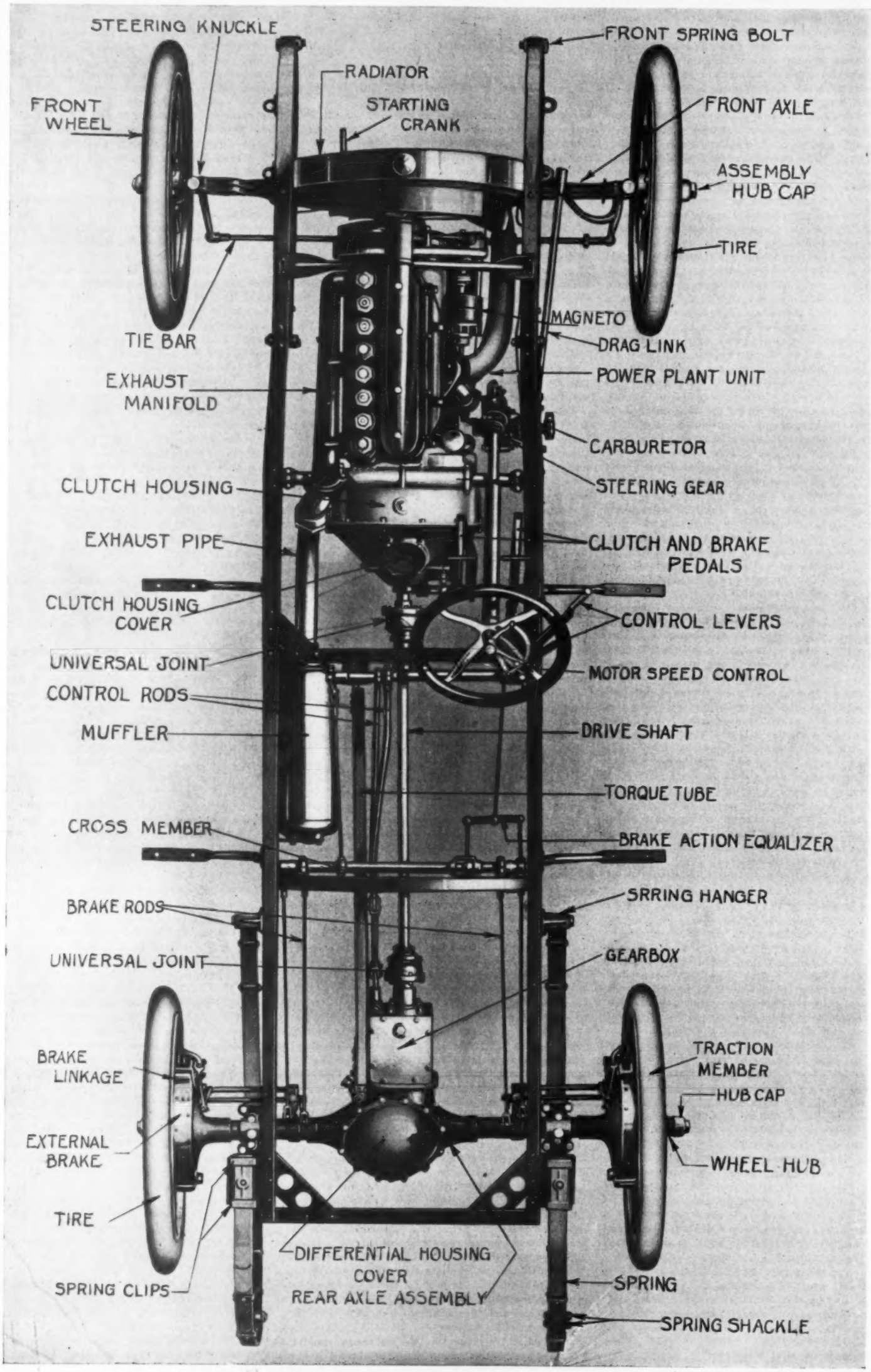
Peaslee, 1913, applied 100,000 volts from a Wimshurst machine on wires 10 inches from the soil to seedlings, with results which he describes as disastrous, at first. Later, by applying the voltage only at night and on cloudy days he increased the growth of strawberries 27 per cent, and beetroots 14 per cent, tops 39 per cent. He could not establish any optimum voltage. He found that the size of the wires made no difference. Climatic variations appeared to have considerable effect.

Preliminary tests with a Tesla coil gave qualitatively similar results.

CONCLUSION.

The impression gained from the literature of electroculture is that the last word is by no means said. From the nature of the publications it would appear that the individual investigations have been too cursory. There has been too little systematic variation of conditions, and especially of the electrical conditions. It seems highly desirable that a much more extensive investigation, providing the possibility of trying different intensities of electrification under various conditions of cultivation, irrigation, etc., all during the same season, should be carried out. It is significant that the only investigator to attempt an extended examination of the field was able to locate and eliminate many faults in his method, and thus obtain good results in the end in almost every case, often reversing his previous experience. If Lemström, working with his very imperfect equipment and limited resources, could attain so much success, greater development still should be possible with the more adaptable apparatus now available.

The theories as to the actual mechanism of the action of the electric discharge upon plants, involve questions of physiological and botanical chemistry whose answers are still too uncertain to make their consideration here of profit. Lemström, Priestly, Escard, and Peaslee discuss the subject briefly, and references to points more or less related to it are given in the bibliography appended to this article.



Structural and operating elements of a typical automobile.

Buying a Second-Hand Automobile

Defects That Are Apt to Exist and Suggestions for Examination Before Purchasing

By Victor W. Pagé, M.S.A.E.

WHEN one considers the magnitude of the automobile industry and the large number of motor cars that have been manufactured, it is evident that many of these vehicles must have changed hands a number of times since they were delivered to the first purchaser. There is a large traffic in used automobiles and many excellent bargains may be obtained if, before a car is purchased, certain precautions are observed in regard to inspection of parts, especially those portions of the mechanism that are hidden from sight. Neglecting these and accepting the statements made by those trying to dispose of the car regarding the condition of the parts means that one is just as apt to secure a worthless machine as one that will be value for the sum expended.

As all machinery depreciates in service, any used car will have worn parts that must be restored to obtain the full efficiency. The amount of deterioration is not regulated by the service the car has given, but largely by the amount of care that has been expended in its maintenance. A machine operated for several months by a careless driver may show more wear than one used for three or four times that period by a careful operator. One cannot judge the value of the car entirely by its appearance as it is much cheaper to give the body and gear a coat of paint and varnish and to daub the motor with enamel and aluminum paint than it is to give a machine a good mechanical overhauling.

The average person is usually suspicious when offered a second-hand car, as, in the majority of cases, the machine is an unknown quantity. This is especially true if the car has been abused and merely tuned up and "doped" to make a quick sale. After the car has been in use for a very short time, the new owner will begin to experience annoying troubles, some of which may be of a serious nature, necessitating expensive repairs, and naturally the one paying for them may soon expend money enough so that this added to the initial investment would have purchased a new car. The disappointed would-be motorist assumes that motor cars are not yet practical, and does not hesitate to proclaim this fact loudly to all who will listen to his tale, and one such man in a community, especially if he is popular and respected, can materially influence many other probable purchasers of cars. If the car had proved successful, he would have been an enthusiast instead of a pessimist and a distinct help to dealers in his neighborhood. Many reputable dealers recognize this fact, and overhaul all second-hand machines they offer for sale in a thorough manner to make sure that the mechanism is in good working condition, and they will not sell any machine they take in trade unless satisfied that the car will give service proportionate to the investment made by the buyer.

Unfortunately, there are a number of dealers who do not hesitate to palm off any car they may have on hand without making any repairs of a permanent nature. These gentry also are prone to make misleading statements regarding the date of manufacture, power and condition. As they sell on a commission they cannot afford to make repairs, but as false statements are cheap plenty of claims are made that will not be supported by the performance of the machine.

A recital of some of the tricks of the trade may be of assistance to the man intending to buy a used car, and at least will serve to make clear why a thorough inspection is advisable to make sure that expensive repairs are not needed. A capable demonstrator may be able to take out a decrepit antique, and by careful manipulation of the spark and gas levers, slipping the clutch to let the engine speed on hills, avoiding the worn gear ratios in the gearbox and avoiding bad roads or hills, give a demonstration of a car's ability that will prove satisfactory to an unmechanical purchaser, and may sell the car for much more than it is worth.

The writer knows of a number of cases where cars have been sold after a tuning up that failed before the purchaser had run the car a week. One motor in particular that he was called upon to inspect showed how unscrupulous dealers may "doctor" up a worn engine so a satisfactory demonstration can be made. As the operation of the engine in question soon became unsatisfactory, in fact, only a few days after the proud purchaser had driven the car home from the metropolis where he had purchased it, it was dismantled for inspection. When the cylinders were removed it was seen that two of these had been badly scored by running the pistons at some time or other without adequate lubrication. In order to compensate for the lost compression, due to the scratches, a metal plate about ¼ inch thick had been rivetted on each piston working in the defective cylinders. Badly worn push rod guides had been bushed by wrapping a strip of shim stock around the valve plunger to take up lost motion at that point. The main bearings and connecting rod lower ends had been bushed in a similar manner. In addition to this, the engine had been oiled by a very thick cylinder oil, the purpose probably being to have this cushion the shock due to loose bearings. The fly-wheel was loose on its key, but this had been temporarily held tight by putting in more of the shim stock at the sides of the key.

The transmission system was but little better. After removing a thick grease, impregnated with what appeared to be wood fibers, from the gearset, it was seen that the intermediate and slow speed gears were so badly worn and burred that new ones had to be obtained. In addition to this, the badly worn cone clutch facing had been made to hold by driving in rubber bands between the cone and friction material at all points between the rivets where the leather could be pried up for their insertion. The ball bearings in the gear-box were badly worn; in fact, those supporting the counter-shaft, which was placed under the mainshaft, were so filled with wood particles that the balls were tightly wedged in the separators and just slid around between the bearing races. In demonstrating, the driver had avoided using the gears as much as possible, doing all of his driving on the direct drive or high speed which did not call for rotation of any gears except the constant mesh members, which seldom wear enough to cause noise because they are not clashed into engagement as the shifting members are.

Every point about the car required adjustment, and at every worn bearing point more of the shim stock bushing was found. After the car had been fixed up as it should be, the cost of repairs was about half the total investment in the car. A new model of the same make could have been purchased for less than the final cost after repairs were completed.

There are still some dealers who would be dishonest enough to take advantage of every means to dispose of a car, so a few hints in regard to the points that can be examined with profit may be of value to future motorists contemplating the acquisition of a used car. There are many exceptional bargains offered in used cars which are really desirable. For instance, there is that class of owners who must always have the latest model, even though the car they purchased the year before is still in perfect condition. These cars, if well-known standard makes, require practically no attention to restore them to a satisfactory operating condition. Such cars are of special value to the man who wishes a good car but who does not feel able to pay the price a new model of this kind would cost. Many cars of this nature are sent to the factory or overhauled by factory experts and are sold with the same guarantee that is given with a new car. Such a car is always a good buy, but as they are more costly than those that appear to be equally good offered by brokers and commission men at a lower price, many prefer to take a chance in securing what they think is a bargain.

As a guide to the non-mechanical purchaser, the writer has prepared the accompanying illustration which represents a plan view of a standard chassis, with all points to be mentioned that need inspection clearly indicated. While motor car designs vary, this one is sufficiently representative of conventional design to serve as a chart for systematic inspection of the contemplated purchase. If the car is offered at a very low price, one may be sure that there is some defective condition that makes it desirable for the owner or his agent to unload. As a rule, the second-hand dealers will not permit a buyer to make a thorough inspection of cars they handle if these are not in first-class shape. If permission to look over the car is denied, the would-be purchaser may accept this as positive evidence that there is some defective part it is desirable to conceal and should look elsewhere.

Buying a second-hand car involves an expenditure of several hundred dollars, to say the least, so a purchaser should feel that he has the right to thoroughly inspect any car offered for sale. In fact, it is desirable to pay a skilled, honest mechanic to make the examination if the buyer does not possess the necessary technical skill or knowledge of motor car construction.

The first point to receive attention is the power plant and its auxiliary systems, as this is the most important unit in the car and the most costly to repair if defective. The amount of compression in the cylinders may be accepted as a rough and ready test for engine condition. Turn over the crankshaft slowly with the starting crank, testing one cylinder at a time by opening the compression relief cocks or removing spark-plugs from all except the cylinder to be tested. If the piston does not encounter a positive resistance to upward motion, this is an indication that the engine is not in the best of condition. The valves may need regrinding, which is not a serious fault, or the valve heads may be scored, pitted or warped, a more expensive condition to remedy. The cylinder may be scored, the piston rings broken or stuck or the cylinder bore worn out of round. Rock the fly-wheel slowly back and forth if that member is exposed, to note if there is any looseness in the connecting rod bushings, which will manifest itself by a knocking sound. The skilled mechanic can detect looseness at these points merely by the "feel" at the starting crank. If possible, remove either the cylinder head casting or the bottom plate of the crankcase, preferably both, to examine the engine interior. The connecting rods may be lifted by the hand to detect looseness after the bottom plate is removed and the crankshaft may be tried for looseness of main bearing by placing a jack under the crank webs and lifting on the handle. Depreciation will be indicated by a slight vertical movement of the shaft. Test the valve operating system for wear by noting the amount of lost motion between the valve lift plungers and plunger guides, and in the rocker arms as well if overhead valves are employed. Lost motion at these points may mean a noisy motor.

A good idea of the care the car has received may be obtained by examining the engine for superficial defects such as scars, rust or scratches on the parts. The wiring, spark-plugs and magneto should be examined carefully. The wiring should be in good condition, with the insulation free from cracks and oil deposits. See if the magneto and carburetor are of modern or obsolete design as this will give some indication of the age of the car as will the general engine design. Wear at the various small joints of the control levers will indicate the service the car has given in many instances. Examine the carburetor and note if there is any leakage of fuel from the float chamber which means a defect in that member. Look over all the nuts and boltheads, rods and pipe and notice if the surfaces are marred or edges chipped as by a cold chisel or pipe wrench. If these are bruised it indicates that the car has been poorly looked after, as nothing indicates the careless mechanic more than bolts or nuts that have been turned by a chisel and hammer or a Stilson wrench instead of a properly fitted spanner. Patches on the water jacket show that these have been filled with ice at some time, another indication of carelessness. Note also if parts are held together by proper fastenings or if they are joined by pieces of wire, as wires indicate temporary repairs and lack of thoroughness. Examine the water connections, pump and radiator for leaks, as these also indicate inadequate attention. Test the fan bearings for looseness and look at the fan belt, and if it is oil soaked, cracked and loose, it is further proof of lack of attention on the part of the former owner.

If examination satisfies the inspector that the engine is not in bad condition, have it started and note the regularity of running. If the engine will not slow down it shows that the mixture is defective, this usually being due to air leakage caused by deterioration of the inlet valve stem guides in the cylinders, which condition indicates long and hard service. Note particularly if the engine runs quietly. Knocking sounds are usually due to one of three conditions, carbon deposits in the combustion chamber, mechanical depreciation at bearing points and overheating due to defective cooling or lubrication. If the demonstrator claims the trouble is due only to carbon deposits, suggest that he remove these, which is not an expensive job, and call again later to learn if the knocking has vanished with the carbon. If the radiator steams after the engine has been run but a short time, it shows defects in the cooling system or faulty lubrication. If the exhaust gas is full of white or grayish smoke it shows that the internal engine parts—the pistons, rings or cylinders—have worn sufficiently to allow the oil to pass through the engine. If the exhaust gas is full of black smoke, this shows an excessively rich mixture. A worn engine will often run with a rich mixture when it will misfire with one of proper proportions. Squeaks denote dry bearing surfaces, rattling shows wear in valve operating mechanism, grinding indicates worn timing gears, hissing denotes compression leaks, whistling sounds leaky packings in crankcase, while a sharp hiss or blowing sound shows exhaust gas leakage at some point. Irregular operation or misfiring usually shows faulty action of the ignition system.

Next in order to the power plant comes the clutch

and gear-box. The condition of the clutch can be best determined when the car is demonstrated. If the engine races and the car fails to move correspondingly fast, it means slipping; if the car starts with a jerk, it shows harsh clutch action due to a charred or stiff clutch leather on a cone, or burred and scored plate surfaces if the clutch is a multiple disk type. If there is any difficulty in shifting gears promptly, the clutch probably does not release completely, this indicating defects in clutch spring thrust bearing or drag between the clutch members at some point. Take the cover off the gear-box and see what kind of grease is used for oiling. If the grease is full of granulated cork or wood fibers, it is reasonable to assume that the gearing is badly worn when recourse is had to such a nostrum to secure quiet operation. Examine the edges of the gear teeth, especially those of the intermediate speed members carefully to see if they are badly burred or worn. The condition of the intermediate gear teeth is a good indication of the amount of service a car has given or the skill of the former operators as this speed ratio is the one most widely used. Grasp the main shaft firmly and try to move it up and down. Any vertical movement indicates wear of the bearings. Do the same with the countershaft. If there is much movement, it not only means that the gearing will be noisy in action but that difficulty may be experienced in shifting gears. It also indicates that new bearings are needed, which means considerable expense if these are of the anit-friction type. Examine also the amount of wear between the shifting forks and the sliding members on the main shaft. This will not be serious unless the car has been used for a long time.

If the change speed gearing is of the friction disk type, look for wear on the fiber wheel as well as on the driving disk. If the fiber is "broomed" over the edges or if the disk is badly grooved, it means slipping and failure to drive positively. If the gearing is a planetary type, examine the linings of the bands. If these are worn and the drums grooved it is a good indication that the gearing has been in use for a long time. A worn planetary gear is also very noisy when the engine is running idly or in low speed ratio.

The usual method of power transmission from the gear-box to the axle drive gears is by shaft and one or two universal joints. Wear at the universal joints can be detected by grasping the shaft firmly and trying to oscillate it. If side chain drive is used on a pleasure car the model is at least four years old. Chains are tested by bending the slack portion sideways to see if the joints are worn. The sprockets should be examined to see if the teeth are worn hook-shape as this indicates extensive use. If the drive is by live axle, jack up that member and test for looseness in the drive gearing by turning the wheels slowly, both at the same time and in the same direction. Lost motion between the wheel hubs and driving shafts, at the gear teeth or universal joints may be easily noted. Turn only one of the wheels, if the other turns of itself in a reverse direction or stands still, the differential gear is functioning properly. If the differential gearing does not work the wheels will turn in the same direction and it will be difficult to retard the motion of either without considerable effort. While the axle is jacked up, it is possible to test the efficiency of the brakes, both external and internal. First pull on the emergency brake lever and try to turn the wheels by grasping the spokes near the rim. The wheels should be absolutely immovable if the brake is holding properly. Release the emergency handle and have some one hold the service brake pedal engaged and repeat the test. Remove the cover from the differential housing and examine the bevel gear teeth, especially those on the drive pinion which wear fastest. If any pieces are broken out of the teeth or the surfaces flaked or rough, new driving gears will be necessary. Also test the differential supporting bearings by lifting up on the differential case with a pinchbar.

In addition to the points enumerated, there are numerous things to inspect about the chassis. Try the steering gear for back lash at the reduction gears, which is evidenced by the degree of lost motion at the steering wheel. Look over the joints at the drag link or tie bar for looseness. This can best be determined by jacking up the front end of the car. Test the steering knuckles for wear between them and the king bolts; also notice the amount of shake in the wheels. If wheel bearings are in good condition, the wheels will turn easily and will have no shake. A badly worn starting handle bearing or worn ratchet teeth on clutch indicates the amount of service the car has received. The rear wheels must also be tested for bearing looseness. The miscellaneous brake rod bearings, control levers, torque members, spring shackles, spring clips and other similar parts may be tested for looseness as great depreciation at these points show that the car has been used for some time.

The condition of the tires, paint, upholstery and accessories must also be taken into consideration. Casings with blow-out sleeves laced on or with patches cemented to their surface are apt to blow out at any time, as are those with deep gashes or bruises or with exposed fabric. If spare casings are included in the equipment and are nicely encased, do not have any compunctions in removing the case to make sure the casing is a good one. An old, wornout shoe fills out a tire case as well as a good one. If the paint and upholstery is in good condition, it may be taken as an indication that the car has received intelligent care if the appearance of the mechanism points to the same conclusion.

Having carefully examined the car, you are ready for a demonstration. See that there is no great difficulty in starting the motor and that it does not vibrate unduly or make much noise. Before going out, insist on having the full number of passengers the car is supposed to carry. Occupy a seat convenient to the driver so you can watch the way the car is controlled. Observe the action of the clutch, see if the car will start smoothly, without jar or noise and if the gears shift promptly and without noise. Note the ease of control, the accelerating qualities of the motor when the throttle is moved and where it is necessary to set the spark lever. If the spark is not advanced much, it means that the driver must nurse the car along. Note if the car is easy riding on rough pavement, not only on smooth roads, and also if it rattles or squeaks when operated at moderate speed over rough highway surfaces. Pick out your own route for a demonstration, taking a variety of roads, some rough, some well paved. Be sure to try the hill climbing ability of the car and note closely the gear ratio required to surmount gradients. If the hill is moderately steep and the car takes it on the high or intermediate speeds, you may be assured it will have power enough for your needs. Have a demonstration of at least 50 miles. Any old car will run around a city block a few times without trouble. Have the gasoline tank filled before starting on the demonstration, and on returning see how much will be needed to refill the tank. This will give some idea of the fuel consumption of the motor.

The more expensive the car, the more thorough the inspection of parts and demonstration should be. Do not buy a big car because it is cheap and appears to be a lot for the money. A white elephant would be expensive to the average man at a cost of one dollar. Do not buy some millionaire's discarded plaything unless you have enough to maintain it, in which case you will not need to buy a second-hand car. If you purchase from a dealer, be sure he is responsible; if from a private owner, be sure he is a bona-fide and not merely a commission man posing as such. Check his claim with the State registration figures. If the demonstration is satisfactory, but several adjustments or some repairs are necessary before the car is in proper condition, stipulate that all of these shall be made before delivery of the car, and do not pay for it until satisfied that the alterations have been made. Take your time in the selection of a car; examine several, weigh their relative advantages and suitability for your use, and if possible patronize some responsible dealer, and your purchase will be entirely satisfactory.

The equitable charge for second-hand cars depends entirely upon the popularity of the make in question. Even the most popular car will depreciate in value about 30 per cent the first year on an average. The two-year old car will have depreciated 50 per cent in that period, a three-year old model should be available at about 40 per cent of its cost when new. After that point a certain rock-bottom value is reached which does not change much as long as the car remains serviceable.

An Inventors' Bank

By Our Berlin Correspondent

THE world is indebted for the greater part of its material prosperity to inventors, that is, a class of people who, so far from enjoying universal esteem, are rather treated as Society's step-children. While inventors have done so much for the world, practically nothing has been done for them. How insignificant is, in fact, the slight service tendered by Patent Offices, as compared with the inventor's whole-hearted devotion! Apart from the fact that the frequently inadequate protection must be purchased by pecuniary sacrifices which the average inventor only too often is unable to afford, a patent unfortunately conveys no guarantee of success. Official records go to show that only a small fraction of all the inventions approved by the Patent Office actually find their way into industry, while even of these only a few achieve anything like real success. Though among those nipped in the bud there are many inventions of a perfectly useless description, others doubtless deserved a better lot, and their disappearance means not only the definite end of hope to the hapless inventor, but the loss of considerable, may be inestimable, values to humanity.

While the State spends a great part of its budget in the purely negative endeavor to protect the national wealth against possible attacks from outside, it so far neglects another task of a more positive character, viz., promoting the inventors' work and thus directly increasing the wealth of the nation. Whereas practically all professions find credit with some bank or other, on their produce merchandise, etc., there is so far no banking institute granting its financial aid to inventors, and unless these succeed in obtaining the assistance of private parties, or have some financial means of their own, the way to success will never be open to them.

A Rumanian engineer living in Berlin, Mr. E. Schnürer, has devised a scheme which, if properly realized, might result in the efficient assistance and utilization of inventors' work. According to Schnürer's opinion the German Empire, with a yearly expenditure of 12,000,000 marks, that is, about four per million of its yearly budget as a maximum, could not only afford to all its inventors, in so far as they really deserve it, the possibility of definite success, but at the same time contribute in no small degree to the progress of humanity. This scheme comprises the foundation of an inventors' bank which, in its laboratories, workshops and testing plants, would, at the inventor's request, develop any invention patented in the country, until its practicability or otherwise has been brought out beyond any possibility of doubt, either with or without the inventor's assistance, the latter alternative applying mostly to the case of layman inventors.

A negative result would be reported to the inventor in writing, with all details as to the factors at issue. If, on the other hand, the practicability of an invention has been brought out, the inventors' bank takes all necessary steps to turn it to account, in Germany as well as abroad, to the best of the inventor's interests, by the sale of patents, granting of royalties, or the foundation of special companies.

Of the profit derived from the invention, the bank would draw for itself 40 per cent until all its expenses are reimbursed, plus 8 per cent interest per annum; after which its share in any further profit would be 20 per cent.

Though there be every reason to suppose that the bank, with so liberal a reward for services rendered, would do good business, there might still be some risk for its shareholders, especially during the first few years, on account of the great novelty of its operations. In fact, even the best of inventions take some time to assert themselves; and it would therefore only be just for the State to grant important privileges to a financial institute bound to exert such a beneficial influence on the economical development of the country.

Whenever all of its shareholders pay in a certain sum, the State would have, in its turn, to pay the same amount to the bank, until a total amount of 250,000,000 marks has been thus paid by gradual installments subject to the following conditions:

Of the yearly net profits of the inventors' bank the shareholders would, in the first place, as far as these profits be sufficient, receive as a dividend, 10 per cent of the capital contributed by them. Of the balance the State would be granted one fourth, year for year, until the payments made by the same (250 millions as a maximum) have been refunded, plus 4½ per cent yearly interest. Even after being thus reimbursed the State, however, will keep its right of controlling the business of the bank.

What would be the actual cost to the State of the sums thus granted to the bank? Twelve millions as a maximum per year, for about sixty years, in the most unfavorable case, i. e., if the State should have paid the bank fully 250 millions without receiving anything in return. The State could, in fact, obtain these sums by means of a 4 per cent loan, redeemable after about sixty years. The advantages to be expected from the working of the bank for individuals and the country at large would, however, in Schnürer's opinion, more than outweigh such a sacrifice of 12 millions a year as a maximum.

In drawing up the statutes of the inventors' bank, care would have to be taken for its mode of working to merit unlimited confidence on the part of inventors. This would, among other things, be obtained by the following regulations:

1. No employees and members of the bank should be allowed to patent anything, directly or indirectly, not even within the first five years of his leaving the bank.

2. The bank should under all circumstances work hand-in-hand with the inventor in everything pertaining to the promoting of his invention.

3. In order to avoid any conflict of interests with an inventor promoted by the bank, the latter should never participate (financially or otherwise) in an undertaking liable to engage in the sale or working of an invention promoted by the bank, unless the latter share in the interests of the inventor at the statutory rate of 20 per cent for the bank and 80 per cent for the inventor.

4. The capital and other means of the inventors' bank should be used by the latter not in working or selling inventions, but only in developing inventions and inducing others (capitalists, business men, or industrial men) to work or sell the inventions promoted by the bank to the best interests of the inventor, in whose profit the bank has a permanent share of 20 per cent.

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Hour Angle Observation of Polaris by Daylight

By Robert V. R. Reynolds, Forest Examiner 1915

OBSERVATION OF POLARIS BY DAYLIGHT.

It has been recognized by surveyors for a number of years that it is possible to observe Polaris by daylight through the telescope while it is still invisible to the unaided eye. The methods set forth for this purpose have not been used extensively, however, because of difficulties in getting the star within the field, and also in finding it when it is known to be there. The required computations of azimuth and altitude of Polaris are often inconvenient and sometimes uncertain for a busy transitman. It is believed that the previous troubles will be overcome if the following table is used and the subsequent directions noted.

TO FIND POLARIS BY DAYLIGHT.

Add to Latitude for hour angles less than 6
Substract from Latitude for hour angles exceeding 6

Hour Angle of Polaris	Azimuth Setting	Altitude Setting
Approximate* (Use suitable interpolations	NE or NW depending upon position of Polaris E. or W. of Meridian	Latitude plus or minus the tabulated quantities
0.0 or 12.0	° 00′	1° 08′
0.0 or 11.5	° 12′	1° 07′
1.0 or 11.0	° 24′	1° 06′
1.5 or 10.5	° 36′	1° 04′
2.0 or 10.0	° 47′	1° 00′
2.5 or 9.5	° 57′	° 55′
3.0 or 9.0	1° 06′	° 50′
3.5 or 8.5	1° 15′	° 43′
4.0 or 8.0	1° 22′	° 35′
4.5 or 7.5	1° 27′	° 27′
5.0 or 7.0	1° 30′	° 18′
5.5 or 6.5	1° 33′	° 09′
6.0 hours	1° 35′	° 00′

*The hour angle used as the argument in this table needs only to be approximate. If it is correct within five minutes sufficiently accurate settings will be indicated provided interpolation is made. Hence there is no need of correcting for longitude until the surveyor has made the observation and is preparing to enter the table of Azimuths of Polaris.

Polaris may always be found in clear weather as soon as the sun has set, and very frequently for five or ten minutes before sunset or after sunrise. It is stated on good authority that under very favorable conditions the observation has been successful as late as 10 o'clock A. M. In the northern United States the cross wires may remain visible for a long time after sunset.

For the novice it is often difficult at the first few attempts to see Polaris while the sky is still bright, but after once having found the star, which appears as a small white dot in the field, he will never thereafter feel in doubt. Granted that the tabulated settings are sufficiently accurate to bring the star in the field, there will still remain several factors which must be given suitable consideration before success can be definitely assured:

1. A slight haziness, which may hardly be obvious to the eye, is sufficient to conceal the star until darkness comes on.

2. The telescope must be in exact focus for celestial objects. This may be accomplished either by focusing at night upon the moon and making a slight scratch upon the objective slide, to show the point to which it should be extended, or the surveyor may focus at the time of observation upon a well-defined object 3 or 4 miles distant, which focus will usually be found sufficiently close. Accurate focusing is one of the most important factors in finding the star, but one that is too often neglected.

3. For the purpose of cutting off objectionable light, the sunshade should always be attached. Additional certainty of finding the star is rendered by throwing a coat or other dark cloth over the head when searching through the telescope, as a photographer uses a focusing cloth.

4. An approximate meridian must be had, from which the azimuth settings are turned off. Commonly the surveyor will already have such a meridian from his backsight. Otherwise, a meridian determination from a solar attachment in reasonable adjustment will suffice. Sometimes, when the magnetic declination is closely known, it will even be possible to turn upon the star from the needle. A reference meridian which is true within 05 minutes or 10 minutes will be precise enough to locate the star when the table of approximate settings is used.

The use of a reference mark is contemplated, such as another station of the survey, or a hub, or a distant, well-defined tree or snag on the skyline. Polaris having been found, the angle from the reference mark to the star should be measured twice, the second time with the telescope inverted. The mean time of observation and the mean angle are then used to find the azimuth of the mark by the simplified hour-angle method. There is practically no chance that any other star will be seen and mistaken for Polaris.

THE SIMPLIFIED METHOD OF COMPUTING HOUR ANGLES OF POLARIS.

The hour-angle method as set forth in the General Land Office Manual of 1902, was too complicated, on account of the required change into sidereal time, to be commonly and confidently used.

The admirable Ephemeris now issued by the General Land Office tabulates, for every day of the year, the Greenwich mean time of the upper culmination of Polaris. The possession of these data in the field makes it possible to easily compute the hour angle of the star at any desired time of observation by simply taking the algebraic difference, in hours, minutes, and length of minutes, between the local mean time of upper culmination and the local mean time of observation. The change into sidereal time is not required.

The following steps are necessary:

1. The tabulated Greenwich mean time of upper culmination must be corrected to the corresponding *LMT* on the meridian of observation by subtracting from it the following correction for longitude:

$$\frac{\text{Longitude}}{360}\ 3.9 = \text{correction.}^1$$

2. If the star when observed is west of the meridian the corrected time of upper culmination, for the civil date of observation, is subtracted from the *LMT* of observation. If the star when observed is east of the meridian the *LMT* of the observation is subtracted from the corrected time of upper culmination for the civil date succeeding the observation. The result in either case is the exact hour angle of Polaris.[2]

3. Using the exact hour angle as an argument, the azimuth of Polaris is derived from the table of Azimuths of Polaris (Ephemeris pp. 14 and 15), interpolation being also made for the declination of the star and for latitude.

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4.5 or 7.5	1° 27′	° 27′
5.0 or 7.0	1° 30′	° 18′
5.5 or 6.5	1° 33′	° 09′
6.0 hours	1° 35′	° 00′

*An hour angle correct within five minutes is sufficient for the purpose of this table. Hence there is no need to correct the time of upper culmination for longitude until the Azimuth of Polaris is looked up in the Ephemeris.

[1] The approximate difference in length between the day of mean solar time and the sidereal day is 3.9 minutes.

[2] In order to make sure of sufficiently accurate azimuth determinations the surveyor should be certain of local mean time within one minute. This requirement is particularly urgent near the times of culmination, when the apparent motion of the star in azimuth is at its maximum.

The Pottery Industry of the United States

A REPORT on the pottery industry in this country has recently been published by the Bureau of Foreign and Domestic Relations of the Department of Commerce that contains much of interest and also some surprising information in regard to manufacturing and commercial conditions, one of the most remarkable of which is that the potters of the United States are without adequate knowledge of the costs of production in their own industry. This is but the natural result of inadequate cost methods, but why such business methods should exist is difficult to understand.

The industry appears to be in a decidedly healthy condition, for it is stated that from 1901 to 1912 the value of pottery products increased 62.5 per cent and profits ranged from 21 per cent to 7.73 per cent, the latter indicating a loss of 4.68 per cent.

Extreme variations in cost of production were found to exist in different potteries, due in no small part to the different conditions in different plants and to the methods of the manufacturers. The successful manufacturers may be divided into three groups: those who have large kiln capacity and market great quantities of excellent ware that is sold direct to large retailers without the intervention of middlemen; small manufacturers who make a white ware of the best quality, well decorated and selling at good prices; the last class produces "scheme" ware, which is sold at relatively high prices to distributers of coffee, tea, cereals, beer, etc.

Large differences in cost of production were found to exist between the potteries of the United States and those of Europe, the level being considerably higher in this country. In fact (except one establishment in Austria), the lowest cost of production in any American pottery exceeded the highest cost of production in any European establishment. This condition will be understood on an examination of the following figures presented in the report: The cost of all materials and expenses, excepting labor, in the manufacture of white ware in the six representative American earthenware establishments averaged 2.05 per cent higher per 1,000 cubic feet of glost-kiln space fired than the cost in English earthenware potteries, 0.25 per cent higher than in Austrian china potteries, 29.2 per cent higher than in German earthenware potteries, and 17.77 per cent higher than in German china potteries. The labor cost for the same unit averaged 81.8 per cent higher in the American potteries than in those of England, 75.96 per cent higher than in German earthenware potteries, 62.9 per cent higher than in Austrian china potteries, and 138.97 per cent higher than in German china potteries. The total cost of manufacturing white ware in the American establishments was 38.43 per cent higher than in the English potteries, 53.65 per cent higher than in German earthenware potteries, 69.15 per cent higher than in German china potteries, and 30.25 per cent higher than in Austrian china potteries.

One of the reasons for high cost of production in this country results from the poor location and bad arrangement of the plants, which have had a haphazard growth. As a rule American potteries have evolved from small plants, and as business increased poorly arranged additions were made, so that only a few establishments have thoroughly modern plants equipped throughout with up-to-date machinery. Many of the establishments are poorly located in reference to transportation, convenience to their supplies of raw materials, and to their markets. The machinery and equipment in use in American and foreign potteries are fundamentally the same, but the American establishments have been slow to improve working conditions and to increase their efficiency by the installation of some improved devices successfully used in foreign factories, and in many cases it would appear good policy to scrap the plants and establish complete modern outfits in suitable locations.

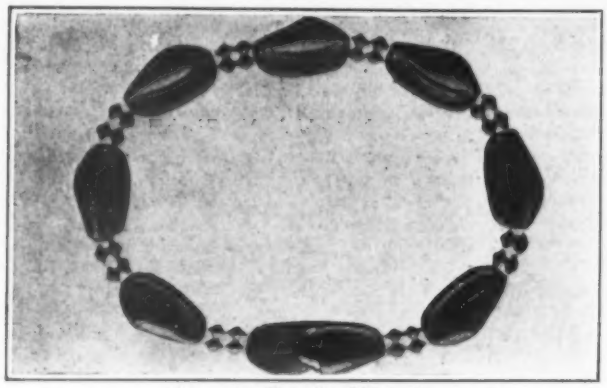
Competitive prices of American and foreign ware in the United States are not determined solely by the difference in costs of production at home and abroad. Other factors, including customs duties, transportation charges, and incidental expenses, are sufficient to offset the difference in cost of production.

In spite of the fact that the average wages paid in American potteries in the different occupations are higher than those paid in European potteries by from 90 to over 600 per cent, the labor cost per unit of product never shows so great a difference as 82 per cent (except in German china plants). This indicates the greater efficiency of the American workmen.

The wages for American skilled workmen in earthenware potteries were from 91.05 to 236.28 per cent higher than in the English potteries, while the cost of labor per unit of product was 81.8 per cent higher in the American potteries. The fact is that, while workmen in foreign potteries receive less in wages than the American, they do not give as valuable a return for their wages. The difference is even more striking in the Austrian and German china potteries. The American wages were from 151.94 to 660.24 per cent higher than in the Austrian establishments, but the labor cost per unit of product was only 62.9 per cent higher in the United States. American wages ranged from 150.99 to 582.8 per cent higher than those in German china establishments, while the difference in labor cost per unit of product was 138.97 per cent. In no case was the difference in average labor cost per unit of product so great as the minimum difference in wages for the same occupation.

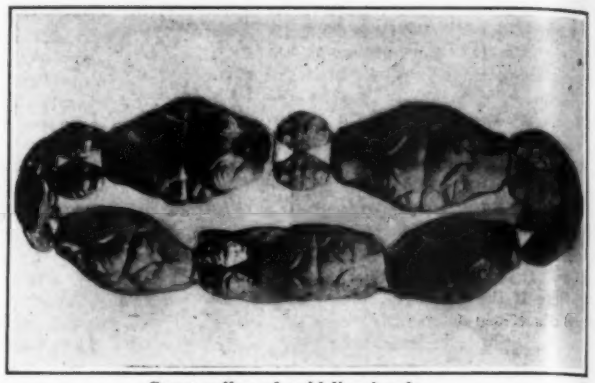
It is expected, however, that the American workman shall provide for himself the many benefits which European countries have arranged for him. Included under the general title of social insurance, the European workman is provided against the contingencies of sickness, especially occupational disease, which is unfortunately prevalent in this industry, and accident invalidity, old age, or death, and in some cases of unemployment.

There is a distinct need for more scientific methods of production, which can be brought about only by highly skilled instruction and more scientific research work. There are twenty-two technical schools in Germany and eight in Austria devoted to instruction in ceramics and the development of the pottery industry. England has a number of high-grade schools in which similar instruction is given. In the pottery centers of the United States there are no such institutions, and the average pottery in this country cannot afford to employ a scientific ceramic chemist who is not also a capable practical manager, a combination of qualifications which is rare indeed. The work of the Technical Chemical Research Institute of the German government indicates what might be done in this direction. The practical co-operation of the United States Government, through the Bureau of Standards of the Department of Commerce and other Government agencies, with the manufacturers is accomplishing much in advancing the standard of American pottery.

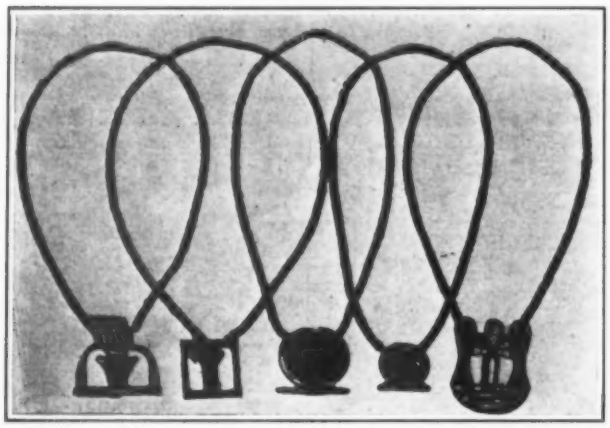


A great collar of gold cowries.

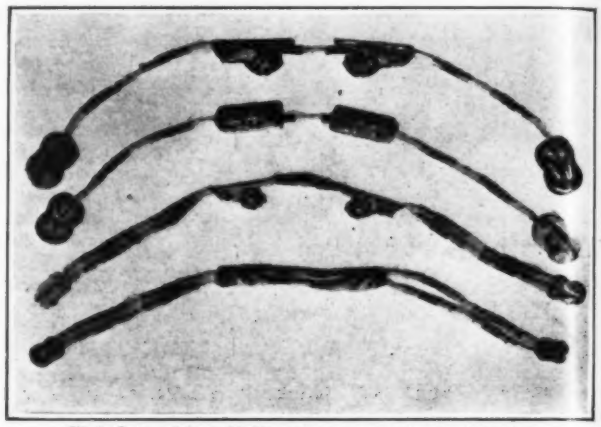
A braclet with gold bars and beads.



Great collar of gold lion heads.

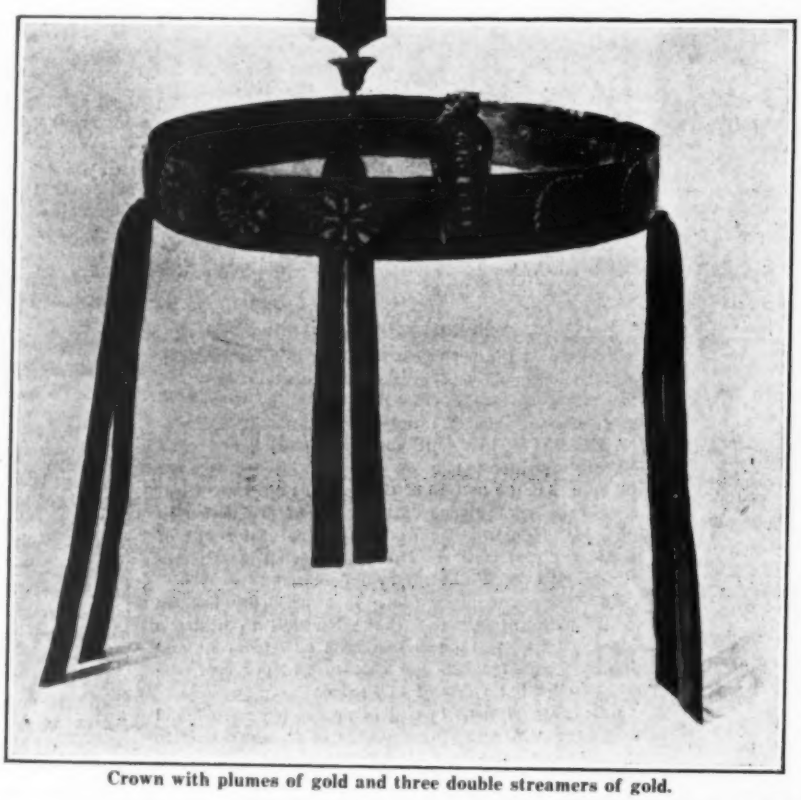


Motto pendants on strings of gold beads, worn around the arm.



Wristlets with gold lions between strings of beads.

Armlet with name and titles.

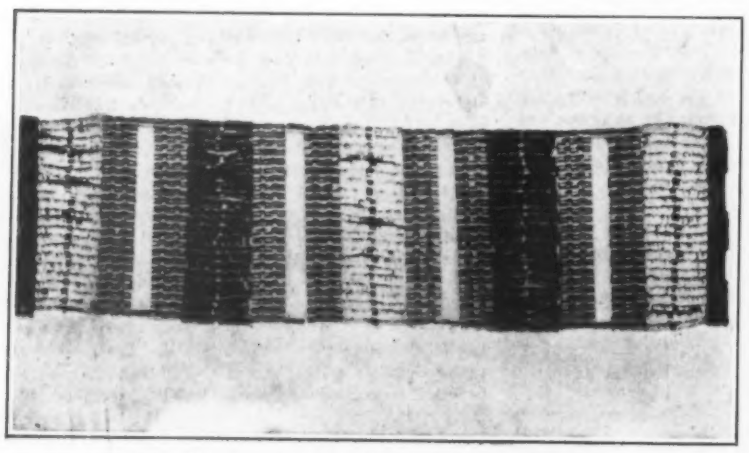


Crown with plumes of gold and three double streamers of gold.

Copper razors with gold handle.

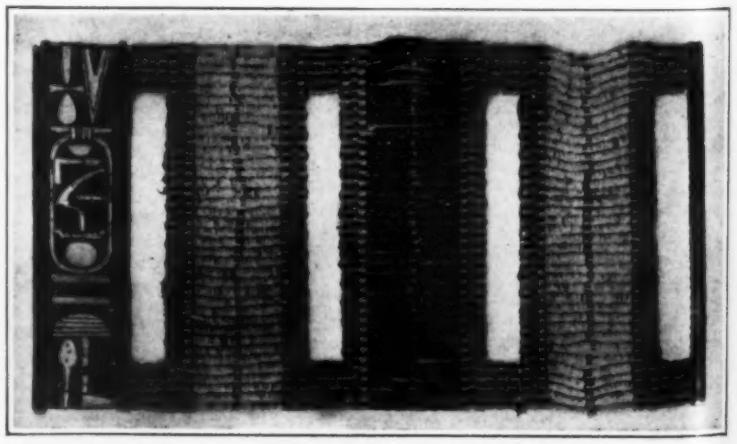
Gold pectoral inlaid with stones. (Amenemhat III.)

Gold pectoral inlaid with stones. (Senusert.)



Bracelet open, showing the two sliding joint edges.

From the *Illustrated London News*.



Armlet of gold bars, with turquois and carnelian beads.

The Treasure of Lahun*

Beautiful Jewelry Ornaments and Tools Found in a Plundered Pyramid

By W. M. Flinders Petrie

A TALL grey pile of brickwork stands high on the desert edge at the entry to the Fayum, some sixty miles south of Cairo. Here was buried a great sovereign of the land with all his family: two hundred generations of the descendants of his subjects have come and gone since then. Nearly all the tombs of Egypt were ransacked in early times, probably within fifty or a hundred years of the burial. This King, Senusert II., had no immunity: his pyramid was entered, his sarcophagus broken open; no trace of his burial remained. Likewise the tombs of his family—all were attacked. Five empty tombs stand along the south side of the pyramid, without a bone left in place. When the British School of Archæology in Egypt began work there last December, a complete clearance was planned to lay bare every inch of the site, and clean the rock, so that no passages or tombs could remain unsearched. In that clearance the five tombs just named were reopened, and entirely cleared out. Two of these had not even a coffin left. The others had sarcophagi totally bare; everything seemed to have vanished. In one tomb the wide pit descended by back steps in the rock to a depth of about twenty-eight feet, and at the end stood a granite sarcophagus, the lid pushed back as far as it could go, and then bruised and broken away so that a boy could crawl in and destroy the burial. Not a chip of the mummy or its wrappings was left behind. Hours, perhaps days, of work had been spent on thus ransacking the grave. Yet all the time, close by the plunderers' side, was a recess in the tomb which they disregarded. There, so close by that a tall man might have touched the crown with one hand and the sarcophagus with the other, the treasure lay quite undisturbed and unnoticed. After the tomb was opened it stood a yawning pit, gradually filled up by occasional storms once in a few years washing down mud. Slowly the caskets rotted, the vases fell over, the threads decayed, the beads rolled apart, and in perhaps fifty or a hundred years the whole pit was filled with mud and dust, and lost to sight. How such a considerable treasure can possibly have escaped the notice of men who were zealously searching for it, is one of the mysteries of the inexplicable past.

In the midst of the recess lay the crown: the tall plumes of gold and the three double streamers of gold all lay down flat, with the crown between them. They had evidently been carefully deposited, and never disturbed. The crown is a broad band of brilliantly burnished gold, with fifteen beautifully inlaid rosettes of gold around it, and in front of it the royal cobra of gold inlaid, the head of lazuli. This head was missing when the crown first appeared; some days afterward, in washing the earth from the recess, the head was found. Then one eye was missing. I washed and searched minutely, preserving the smallest specks of precious stone. Soon a tiny ball of garnet appeared at the bottom of the basinful of mud; this—no larger than a pin's head—was the missing eye. Yet the gold socket of the eye was missing. I remembered having washed out a bead of gold which differed from thousands of others; looking, I found it again, and there was the setting of the eye complete. Above the crown at the back of it stood up double plumes of gold, fitting into a golden flower. At the sides and back hung down broad ties of gold. The whole crown is too large for a modern head, being made to go over the very full Egyptian wig; it is altogether over eighteen inches high.

The next most striking objects are the great collars of gold cowries and gold lion heads. These are ingeniously fastened with one piece in two halves, joining together by a slider, so that the collar has to be much contracted before it can open. Two beautifully wrought pectorals are of gold inlaid with minute pieces of carnelian, turquoise, and lazuli. In the pectoral of Senusert there are 372 separate stones inlaid. The harmonious outline of these designs, and the exquisite work, make these the most charming examples of Egyptian gold-work.

A great necklace of long drop-beads must have been worn hanging below the other jewelry. The pendants are of gold, carnelians, lazuli, and amazon stone. From the middle hangs the most splendid scarab known, cut with perfect sharpness in the richest lapis lazuli. A larger figure of it is put in the middle. Yet another necklace was of amethyst of the darkest, fullest color, with gold lion claws as pendants.

Armlets were worn of gold bars with minute beads of turquoise and carnelian. They were fastened on the arm by sliding a strip of gold, covered with inlays of carnelian, and bearing the name and titles of Amenemhat III.

Bracelets were of much the same style, only without a loose slider, the edges sliding one into the other. Five little motto-pendants were worn by strings of gold beads round the arm; each pendant has a sliding clasp at the back, to fasten the string of beads.

Four wristlets each have a pair of gold lions, face to face, upon strings of beads of gold, carnelian and turquoise.

The toilet was provided for by a large silver mirror, with a handle of obsidian, and gold head of the goddess Hat-hor; a pair of razors with gold handles; and three jars for ointment made of black obsidian with gold mounting round the base, the brim, and the lids.

The funeral outfit of the sacred oils and unguents was in eight alabaster jars with lids.

The Egyptian government claim half the value of all discoveries, and have retained the crown, one pectoral, and the mirror, in Cairo. All the other objects are in London.

Besides this great group of jewelry, which is the only such treasure that has ever left Egypt, there were many curious things found in the wide excavation around the pyramid. Here we may see two groups of ducks, the one lying dead on an altar with the eyes closed, the other being carried and all alert. These show how minutely the sculptures of the temple were wrought. The first lamps that can be proved to be such by their wicks, were found in the pyramid: they are of limestone with pierced disks of pottery in the central cup, to hold up the wick. Around the cup is a trough to hold water, in order to keep the stone damp so that the oil should not soak away. Of the workmen's tools, there were many mason's mallets, very like those used to-day; wooden rollers for moving the stones, and a wooden hoe.

*Reproduced from the *Illustrated London News*.

How the Science of Preventive Medicine is Minimizing Accidents*

THERE has arisen on the part of good medical thinkers and at the call of an enlightened public, a new medical specialty, the science of preventive medicine. The value of men, women and children in our country is worth in money more than twice as much as are our industries, railroads, land, buildings and improvements. No monetary value can be placed on the health and happiness of humanity.

What has been true of the science of preventive medicine in the past is going to be intensified in the future. Medical sociologists have demonstrated to us the folly of attempting to raise healthy children in the slums. They have shown us the folly of allowing children, our next generation of workers, to reach manhood stunted in knowledge and health by an impossible environment and one that could be controlled.

In many places we are giving our school children a physical examination in our endeavor to find the early traces of disease, and to correct the disorder before the damage is done. Students of the work find that it pays the community in dollars and cents, because they have discovered that a large percentage of the children, who are repeating years in school at an average cost of $26 a year per child, are not doing so because of dumbness and inability to learn, but on account of physical defects that could be corrected.

Recently a new and powerful force has been introduced, which depends upon medical men for its success, and which will do more to alleviate human suffering and economic loss due to accidents and disease, than any previous methods tried. I refer to the activities of the State to classify its accidents, and to place a premium upon their prevention, to teach the truth about occupational diseases and their prevention and to provide the workingman with a healthy place in which to work. I wish to pay tribute to some industrial organizations for their efforts to aid the State in its work, and to their interest in supplementing that work with an accurate knowledge of the physical condition of its workmen, in order that in so far as it is possible no man shall be allowed to do a kind of work that is unsuitable to his physical condition. The very beginning of disease may then be detected long before serious damage is done. This, to my mind, simply is a continuation of the work done, when the school child is physically examined.

What the State's loss of time is, per accident per man, I do not know, but I have learned from experience that for men so badly hurt that a day or more is necessary, the average of 12 days for all injuries should not be exceeded, if the work is most efficiently done. Diminished numbers of infections, with their increased loss of time, 4 days to 1 of the non-infected cases, their deformities and stiff joints, and sometimes amputated members, test the skill, knowledge and efficiency of the medical men. Infections at the Youngstown Sheet and Tube Company, where I have the honor to be employed, number 1 in 914 for all open wounds when treated at once. The ratio of Ohio as reported by Dr. Binkley, chief medical examiner of the State, is 1 in 10, 50 per cent due to the neglect of the injured man himself, and the other 50 per cent to the medical care. Every employer of labor should so organize his forces that care is given the injured man in such a manner as to yield the minimum amount of infections and thus diminish the expense and suffering.

My associate, Dr. Dobbins, and myself, at the plant of the Youngstown Sheet and Tube Company have been engaged for the last nine months in studying the relationship between the physical fitness of men and their working efficiency, as well as the relation of the worker's health to accidents. We feel sure that we see clearly in many cases the relation of poor physical conditions, bodily and mentally, to accidents. The test of such work as this is not how many men we can refuse work or remove from work, but how many it is possible to make physically fit or how many can be placed at work that suits their physical condition.

Under our former system we waited until from physical weakness a man consulted a physician, and was told the cause, while in the meantime he ignorantly exposed to infection his wife, children, and fellow workmen. By repeated examinations we frequently find evidences of incipient tuberculosis, remove the man to a sanatorium for cure, while a cure is possible, stop the possibility of the afflicted infecting his family and fellow workmen, and return him in the shortest time necessary for a cure, to his family, and to society, a useful producer and also a non-infecting individual.

Upon the eyesight of all men depends their own and others' safety. I recently examined a motor crane inspector, who had so little vision that he could not count fingers held at arms length. A little advice and a properly fitting pair of glasses made him an efficient and safe man, besides adding to his own comfort and removing his handicap.

It is eminently not fair to ask a heart case to compete for his living with those of sound heart, for sooner or later, the heart case will become incapacitated and become a burden to his family; a public charge maybe; certainly an economic loss. If placed at work suitable to his heart condition, the man may give good service for years. Hernia, or rupture, usually a congenital defect of nature, has been a potent cause of inefficiency as well as a source of physical disease and absolute danger. I have been obliged recently to operate on two men whose herniæ had become strangulated while at work, and required immediate operation to save their lives. It will raise the health and efficiency of men if we place trusses on the suitable cases, and advise operation when it is necessary. Many a man suffers torments from a supposed rheumatism, when in reality he is troubled with flat feet, a condition that if treated with arch supports can be remedied and all suffering removed.

If these methods bring health, happiness and greater safety to the workingman, there is only one way in which the results can be gained, and that is by the frequent examination of all individuals. These same results could be obtained if we would consult our physicians at stated intervals, but we human individuals have not yet learned to spend our money when well, to prevent being sick. Industry is just beginning to learn, that it is worth more to prevent sickness than to wait until "the horse is stolen."

When the proper intimacy between medical man and employee is established; when men are examined, defects found and advice given as to remedy, then exists the opportunity to tell and educate large masses of people regarding sanitary living, proper ventilation of the home, the truth about the seriousness of diseases and how to care for them, as well as how to protect themselves and others from infections.

*Extracts from an address delivered at the Safety Exposition of Ohio held at Columbus by Dr. Sidney M. McCurdy.

Washington-Paris Longitude by Radio Signals*

A Valuable Application of Wireless Communication

By F. B. Littell and G. A. Hill

A PROPOSAL from Capt. J. L. Jayne, U. S. N., superintendent of the Naval Observatory, to determine the difference of longitude between the Naval Observatory at Washington and the Observatoire de Paris at Paris, France, by the use of radio signals from the naval station at Radio, Virginia, and from the Eiffel Tower station in Paris, having been favorably received by the French authorities, preparations were begun by the direction of the Navy Department early in the spring of 1913. The methods adopted were those developed by the French and described in *Détermination par la Télégraphique sans Fil de la Différence de Longitude entre Paris et Bizerte* and other publications.

The longest distance over which the method had previously been applied was in the above mentioned determination between Paris and Bizerte, which distance is about 960 miles, and in order to make sure that the method could be extended to meet the requirements of the present case, the French government sent over a preliminary expedition with four observers in March, 1913. This party was equipped with the astrolabe as modified and improved by Messrs. Claude and Driencourt for the determination of time, and although it was late in the season for successful radio transmission over so great a distance, the party succeeded in securing a sufficient number of radio clock comparisons on two nights to convince them that the radio method would be entirely practicable at a more favorable season of the year.

For the American observers, two new transits were ordered from M. Prin of Paris. They were to be practically duplicates of those in use by the French observers of three inches aperture, thirty-three inches focal length, with self-registering right ascension micrometers driven by electric motor and controlled by hand, reversible on each star, with hardened steel pivots, and electric lighting. A meridian mark and lens of approximately one hundred and fifty feet focal length was provided with each instrument. As it was planned that the work should be done in duplicate by French and American observers working simultaneously, it was necessary to erect two small buildings in the observatory grounds for the shelter of the instruments.

For the second period, all the observers and astronomical instruments were interchanged.

The astronomical programme was to observe from 7:30 P. M. to 1:30 A. M. local mean time at both Paris and Washington. As each star was observed with instrument direct and reversed, the collimation error was eliminated except for a small correction depending on the length of the signals which was applied, the level was determined by the striding level between every two star observations, and the azimuth by means of readings on the meridian marks which were also made between every two star observations. With this programme about five clock stars per hour could be observed. When possible, three or four azimuth stars were observed each night. The observing list for each station was made up so that in any period of three hours the stars were fairly well balanced as to the zenith. Nearly all the stars north of the Washington zenith and south of the Paris zenith were common to both observing lists. The two astronomical observers of each party alternated in observing the first and last half of the evening.

At Washington the Riefler standard sidereal clock sends its signals on the even seconds (omitting for identification the zero second of each minute) to a small break circuit relay which operates a large 7-point break circuit relay which distributes the signals to the various instruments of the observatory. Only one of the seven points being available, it was used to operate a 4-point relay, one of whose points was used to send the clock signals to Radio, one to the French, and one to the American chronograph. As the French chronograph could operate only on a make circuit, and as the American could operate on either, the circuits were arranged as make circuits. By the above arrangement the 4-point relay became practically the observing clock, and it was only necessary to determine the lag of the point used for the chronograph relative to that used to send the signals to Radio. This was done by recording on the chronograph sidereal time signals alternately through the different points, while at the same time mean time signals were being recorded through an independent circuit. When the French observers arrived, Prof. H. Abraham of the Université de Paris brought with him two galvanometer pen chronographs designed by himself and especially adapted for the recording of such lags, and he very kindly loaned one to the Naval Observatory. It was more convenient in use than the other arrangement and gave practically the same results. There was a small systematic difference of $0^s.004$ between the results obtained by the two methods which was attributed by Prof. Abraham to the superior sensitiveness of his chronograph. For a short period at the beginning the relative lag between the Radio and American chronograph points was $0^s.010$. The point then in use having been shown by records on the much more sensitive photographic galvanometer chronograph of Prof. Abraham to be defective, the chronograph circuit was changed to the other available point of the relay and after adjustment the lag was $0^s.000$ and remained so throughout the work. In general two records of the lag were made each night. The time from the closing of the contact at the observatory to the reception of the signal in the telephone receiver at Radio was measured and was found to be negligible.

At Paris the Riefler clock sends its signals on the even seconds (omitting for identification the 58th second of each minute) and synchronizes a "clock relay" which distributes the signals to the chronographs. The synchronizing circuit apparently operates when the pendulum of the clock relay is at its lowest point and the signal circuit is closed near the end of the swing of the pendulum so that the lag is either approximately $+ 0^s.5$ or $+ 1^s.5$, according to the direction in which the pendulum is swinging when it is synchronized, and as the clock relay omits no signals for identification and the signal nearest the zero of the Riefler is usually called zero the result is that the lag is either approximately $+ 0^s.5$ or $- 0^s.5$. If the control is out of action for a time or if the relay is stopped and started again, it is readily seen that the lag may change from one value to the other.

The probable error of a clock correction from a single star, including the errors of star places, would indicate a probable error of $\pm 0^s.008$ at Washington and $\pm 0^s.010$ at Paris for a clock correction from an average night's work of about twenty stars. The intercomposition of results by the different observers on the same instruments and of the results of the French and American observers on different instruments indicates a probable error of clock correction of $\pm 0^s.013$ for Washington, and $\pm 0^s.015$ for Paris, which is considerably larger. The difference is due perhaps to variable personal equations or imperfect instrumental action.

The clock corrections were plotted, and the curves satisfy the observations for Washington with a probable error of $\pm 0^s.012$ and for Paris with a probable error of $\pm 0^s.015$. The use of these curves also furnishes a means of utilizing all the radio observations on whatever nights they were obtained.

As the epoch of the Washington time observations was about 2½ hours after that of the radio observations, and that of the Paris time observations was about 2½ hours before that of the radio observations, the effect of the above differences on the resulting longitudes may be approximated as follows:

I	II	Mean
$+ 0^s.017$	$- 0^s.049$	$- 0^s.016$

At each station the programme for the radio work was essentially the same. At Radio, for example, a Leroy clock controlled the emission apparatus so as to send out three series of 420 signals omitting for identification the multiples of sixty, the intervals between the successive signals being approximately $0^s.99$, and each signal being $0^s.5$ long. The radio observer observed by ear by means of telephone receivers the coincidences of the outgoing signals with the beats of a mean time chronometer, and as the chronometer beat half seconds, he observed a coincidence about once in fifty seconds, or usually seven or eight in a series. He also noted the omitted signals in such a way that the serial numbers of the signals at the coincidences could be determined. With this data it is possible to determine the chronometer time of any desired beat in the series of 420 emitted by the Leroy clock.

The radio signals having been compared with the comparing mean time chronometer, this was in turn compared directly with the standard Riefler sidereal clock of the observatory by the same coincidence methods, securing usually four coincidences for each comparison, and two comparisons each night, one just before and one just after the radio work.

From the comparisons of the signals from the emitting clock with those from the comparing chronometer, it is possible to obtain a chronometer time from each coincidence for any signal in the series selected as a reference signal, and by means of the comparisons of the comparing chronometer with the Riefler clock and the determined corrections to this clock, it is possible to obtain the local sidereal time of this reference signal. In order to eliminate the errors in the assumed rate of gain of the emitting clock on the comparing chronometer due to errors of observation, the signal whose number in the series corresponds to the mean of the numbers of the signals at which coincidences were observed should be taken as the reference signal. As this number is different for the two stations, the signal corresponding to the mean of the two numbers was used as the reference signal, and in this way these errors were rendered negligible though not completely eliminated. Having determined the local sidereal time of the reference signal at Washington and at Paris, the difference of these times is the difference of longitude.

The distance from Paris to Washington being 3,830 miles, the ascertained transmission time corresponds to a velocity of 175,000 ± 16,000 miles per second.

The transmission time from Paris to Bizerte (see *Différence de Longitude entre Paris et Bizerte*, p. 107), was determined to be $0^s.0071$, and as the distance is 963 miles, this corresponds to a velocity of 136,000 miles per second.

The correction for time of transmission as determined above has been applied to all the longitude results. All of the available radio observations for each night, omitting series in which but a single coincidence was observed, have been combined to form a single longitude determination. There were nine nights in the first period and eight nights in the second period when astronomical observations were secured at both stations and when radio observations were made at one or both stations. There were also five additional combinations of nights in the first period, and five in the second period when independent longitude determinations can be obtained by carrying the clock correction at one or both stations for from one to three days by means of the clock rate. In view of the excellent installation and good performance of the clocks at both observatories, this is considered a safe proceeding in the present case. The weight assigned for the longitude of a night is based on the number of series of radio observed, the number of coincidences observed in the series, the number of stars observed, and the number of days the clock corrections have been carried by the rates.

From the data obtained values of the observed longitudes have been deduced for the first and second periods of the work:

I	$5^h\ 17^m$	$36^s.616$	$\pm 0^s.0115$
II	5 17	36 .811	± 0 .0054

By applying the correction $- 0^s.056$ to each in order to reduce to the adopted meridians of Washington and Paris, respectively, and taking the mean the following longitude, Washington-Paris, is obtained.

$5^h\ 17^m\ 36^s.658 \pm 0^s.0059$ (*A*)

The probable error assigned is based on the assumption that the difference between I and II is due chiefly to differences of personal equation between the astronomical and radio observers of the two parties and other similar errors and that the effects of those errors are eliminated in the mean. The extent to which this is the case will be shown further on.

If the longitude is based on the seventeen nights on which astronomical observations were made at both stations, the result is

$5^h\ 17^m\ 36^s.642 \pm 0^s.0065$ (*B*).

If the longitude is based on clock corrections derived from the common stars observed the same nights at both stations, thus eliminating the errors of the star places, the number of nights is reduced to fifteen, and the result is

$5^h\ 17^m\ 36^s.628 \pm 0^s.0061$ (*C*)

If the longitude is based on clock corrections derived from the three hour group nearest the time of the radio comparisons at each station, thus reducing the effect of errors in the adopted clock rates, the number of nights is reduced to fourteen and the result is

$5^h\ 17^m\ 36^s.629 \pm 0^s.0073$ (*D*).

If the longitude is based on the seventeen nights as in (*B*) but using clock corrections from the curve instead of the observed clock corrections for each night, the result is

* Abstracted from a paper in *The Astronomical Journal* communicated by Capt. J. A. Hoogewerff, U. S. Navy, Superintendent U. S. Naval Observatory.

$5^h\ 17^m\ 36^s.652 \pm 0^s.0042$ (E).

By the use of the clock corrections derived from the curve, all the radio observations, made on 67 nights, can be utilized.

From the data thus secured the following values of the observed longitude for the first and second periods of the work have been deduced:

I $5^h\ 17^m\ 36^s.614 \pm 0^s.0049$.
II 5 17 36 .813 ±0 .0027.

By applying the correction $-0^s.056$ to each to reduce to the adopted meridians of Washington and Paris, respectively, and taking the mean, the following longitude, Washington-Paris, is obtained:

$5^h\ 17^m\ 36^s.658 \pm 0^s.0029$ (F).

This value is considered the best of the six given above, which, though preliminary, will not differ materially from the definitive values to be published in an appendix to Volume IX, *Publications of the U. S. Naval Observatory*, Second Series.

	I	II
Correction due to diurnal variation in clock rates	$+0^s.017$	$-0^s.049$
Correction due to lag determination for Paris I	+0.010	
Correction due to variation of longitude	+0.001	−0.009
Correction due to systematic differences in levels	+0.026	−0.030
Correction due to difference of radio observers personal equations	+0.020	−0.020
Correction due to difference of astronomical observers personal equations	−0.028	+0.008
Total	$+0^s.046$	$-0^s.100$

Previously determined values of the transatlantic longitudes are as follows:

From Eclipses and Occultations	Years	Washington, Old Obs'y—Greenwich	Washington, New Obs'y—Paris
1. Walker	−1843	5h 8m 11s.14	5h 17m 35s.70
2. Peirce	1851	11 .57	36 .13
3. Peirce	1839	11 .45±0s.3	36 .01
4. Peirce	1856–1861	13 .13	37 .69
From Moon Culminations			
5. Walker	1843–1845	10s.01	34s.57
6. Loomis	1838–1844	9 .3	33. 86
7. Gilliss	1838–1842	10 .04	34 .60
8. Walker	1845	9 .60	34 .16
9. Newcomb	1846–1860	11 .6 ±0s.4	36 .16
10. Newcomb	1862–1863	9 .8	34 .36
From Chronometers			
11.	−1849	12s.46	37s.02
12. Bond	1849	11 .14	35 .70
13. Walker	1849	12 .00	36 .56
14. Bond	1849	12 .20±0s.20	36 .76
15. Bond	1855	13 .43±0 .19	37 .99

By Cable	Years	Cambridge—Greenwich	Washington New Obs'y—Paris
16. Gould	1866	4h 44m 30s.891 ±0s.090	5h 17m 36s.56
17. Dean	1870	31 .065 ±0 .056	36 .73
18. Hilgard	1872	31 .016 ±0 .041	
		Cambridge—Paris	
18. Hilgard	1872	4h 53m 51s.951 =os.051	36s.69
		Montreal—Greenwich	
19. Greenwich Obs'y.—McGill University	1892	4h 54m 18s.62 ±0s.024	36s.70

In reducing these longitudes to Washington-Paris, the following adjusted differences of longitude have been used.

20.	Greenwich—Paris	0^h	$9^m\ 20^s.932$
21.	Washington—Cambridge	0	23 41 .107
22.	Montreal—Cambridge	0	9 47 .588

23. Washington, New Observatory—Old Observatory ..... 0 0 3 .631

The Washington-Paris longitude given in the *American Ephemeris and Nautical Almanac* for 1901 to 1915, $5^h\ 17^m\ 36^s.75$, is correlated with the Paris-Greenwich longitude, $9^m\ 20^s.97$, which has been superseded by the value $9^m\ 20^s.93$, corresponding to a Washington-Paris longitude of $5^h\ 17^m\ 36^s.71$. This value depends on the Washington-Greenwich longitude resulting from the adjustment made by Schott,[1] which is

$5^h\ 8^m\ 15^s.78 \pm 0^s.05$

This longitude depends largely upon the result of the 1892 cable determination of the longitude Montreal-Greenwich. At the time of the adjustment only the preliminary value of this result was available. As the definite value gave a correction of $-0^s.05$ to the preliminary value, it is evident that Schott's value of the longitude Washington-Greenwich is too large.

Assuming the Greenwich-Paris longitude[2] to be

$0^h\ 9^m\ 20^s.932 \pm 0^s.014$

the Washington-Greenwich longitude resulting from the present determination is

$5^h\ 8^m\ 15^s.726 \pm 0^s.014$.

1-15. *U. S. Coast Survey Report*, 1867, pp. 59, 60.

16, 17, 18. *U. S. Coast and Geodetic Survey Report*, 1897, pp. 247, 248, see also p. 241 and 1872, p. 234 and 1884, p. 429.

19. Royal Observatory Greenwich. *Determination of Longitude*, 1888-1902, p. 124.

20. *Astronomische Nachrichten*, No. 3993, p. 157.

21, 22, 23. *U. S. Coast and Geodetic Survey Report*, 1897, pp. 253, 260.

[1] *U. S. Coast and Geodetic Survey Report*, 1897, pp. 254, 256, 260.

[2] *Astronomische Nachrichten*, No. 3993, p. 157.

How Narcotics Affect Plants

The term narcotics is given in general to those substances which exercise a powerful effect on the central nervous system of men and animals. This effect consists mainly of a period of excitation followed by a period of depression or reduced sensibility, which may end in stupor or even in death. However, the total effect is a complex of phenomena, which vary according to the nature, the dose, and the duration of the narcotic.

There is no physical or chemical property which all narcotics certainly possess, but the majority of them are marked by volatility and an intense odor, nearly all are soluble in lipoids or fatty substances, and it seems probable that all are able to penetrate living plasma.

While plants cannot be said to have a central nervous system, the studies of plant physiologists in recent years have increasingly shown a marked analogy between their vital functions and those of animals. Among the most striking of these analogies are the way in which they react to certain narcotics. Many investigators have of late been experimenting along this line, and the results of their research are lucidly set forth in an article by Dr. Arthur Heilbronn in *Die Naturwissenschaften*, which we here summarize.

It is very difficult to distinguish between narcotics and poisons, for in large doses or too great duration the former are always fatal. But susceptibility to them varies greatly in species and individuals, and the same thing has been found true of plants. This susceptibility, too, can be lessened by gradually accustoming the individual to larger and larger doses, a fact of which Dumas made romantic use in one of his most thrilling novels, and which De Quincy verified in real life, as do all "drug fiends." Even so can plants be inured to the narcotics.

The best known narcotics are alcohol, ether, and chloroform, but there are many others, among them benzol, xylol, and benzin. Narcotic gases include the compounds of hydrogen and oxygen in illuminating gas, carbon dioxide, and the fumes of ammonia and Prussic acid. They also include such solid bodies as chloral hydrate, certain compounds of calcium, and many alkaloids. It is also a form of narcosis termed by Dr. Heilbronn *autonarcosis*, which occurs in plants surrounded by an atmosphere having insufficient oxygen, a condition which may occur when the temperature is either too high or too low. "Perhaps," he says, "the abovementioned carbon-dioxide narcosis belongs in this group. We must believe that under these abnormal conditions of metabolism narcotic substances are formed in the plant. . . ."

Zaleski proved that respiration in onions was stimulated by a narcosis of six hours, but depressed when the duration was longer. A practical application of this stimulation of respiration is given in the Johannsen process of forcing by ether. In this the ether produces not only acceleration of respiration, but, indirectly, of growth. A narcosis of from 12 to 48 shortens the rest-period in various plants from six to eight weeks.

"In these cases the narcotic develops its effect only in the preliminary and after-periods of rest and not in the middle period. In both periods a struggle takes place between the stimulation and the inhibition of growth. The ether is favorable to the first process, hence the result attained. This phenomenon has an analogue in the animal kingdom: the rest-period is shortened by ether both in the eggs of insects and the pupæ of butterflies, according to Fischer. A success similar to that in the forcing of twigs in their winter rest-time is attained in the case of grains of barley, which have just matured and are in the early period of the rest-time. They may be made to germinate while still attached to the parent plant, a case of experimentally obtained viviparv."

Another remarkable instance of the modification of vital functions by narcotics is the checking of fermentation, according to Claude Bernard. Dr. Heilbronn, however, considers this so astounding that it is in need of proof by control experiments. It is certain, though, that assimilation may be temporarily checked by narcotics oth in the Algae *Spirogyra* and in higher plant forms. "This inhibition is probably only a special case of the quite general anticatalysatoric effect of many narcotics, i. e., their ability to retard chemical processes which are set in operation by a catalysator. This may have its fundamental cause in alterations of surface-tension relations in narcotic atmospheres."

The effects of narcotics upon transpiration are quite curious. Mildly narcotized leaves transpire more strongly in light, but less strongly in the dark, than the normal. Jamelle gives the following explanation for this: assimilation is interrupted by the assimilation, and consequently the entire energy of the rays of light absorbed by the chlorophyl is utilized in transpiration. Dr. Heilbronn considers this debatable and discusses it at some length.

Another effect of narcotization is interference with the process of assimilation. The conduction of products of assimilation in germanating seeds is cut off, since they cannot pass through narcotized leaf-stems or pieces of the stalk. This is considered additional proof that the co-operation of the living plasma is indispensable for the conduction of assimilated substances. But hydrolytic processes, such as the dissolving of starch, continue. The natural consequence of this is an accumulation of osmotically active substances, such as sugar, asparagin, etc. An increase of osmotic pressure is necessarily associated with this, and this leads in its turn to rankness of growth. In this connection it is of especial interest to note that there is a displacement in the growth. The longitudinal growth is checked, while the growth in thickness is advanced. But this holds good only for mild doses. A stronger narcosis interrupts all growth.

Dr. Heilbronn also dwells at some length on the manifold modifications of the nuclei of narcotized plant organs and the influence of narcotics on the plasma-current. Without entering into the technicalities of the discussion we may quote the following passage: "It is evident that the viscosity of the living substance is increased by large narcotic doses, and we have known also since the earliest studies of narcosis in plants that a typical criterion for narcotic action is a decrease in intensity of reaction to exterior stimuli. It is an obvious matter to bring these two facts into casual connection and to regard alterations in the physical structure of the plasma as the cause of the altered physiologic function."

The decrease of sensitiveness was the first thing which led to the discovery that there was such a thing as narcosis in plants. Marcet proved as far back as 1848 that the mimosa ceased to be sensitive under the influence of chloroform, and the next year Clemens showed that ether had the same effect. Many other observers noted the influence of narcotics on various plants in inhibiting curving movements.

Dr. Heilbronn accounts of special interest Czapek's observation that the geotropic curving capacity of a plant organ is suppressed by a considerably lower concentration of a narcotic than its geotropic sensibility; consequently, therefore, the curving capacity is inhibited by a mild narcosis while the perception capacity is retained at the same time. Hence, it is possible to induce a geotropic stimulus in narcotized legumens as whose result after the sleep-state has passed away there follows a geotropic curving, though the stimulus is no longer present. We pass over the theoretic explanation of this. He continues: "We have just mentioned a case in which perceptivity is retained while motility is inhibited; the following example shows that the reverse can be the case, at least for light stimulus: *Bacterium termo* retains its motility completely in mildly narcotic liquids; but while it constantly hastens toward the source of light it has entirely lost its phototropic sensibility."

An interesting point is that in organisms which react with the same movements to different stimuli it is possible to differentiate these stimulus-movements by the aid of narcotics. Thus, the mimosa responds to a touch just as it does to the withdrawal of light; but, according to Brücker, there is a certain dose of ether which just suffices to make the plant insensitive to touch while retaining its "sleep-sensibility."

"The tropisms likewise exhibit a various sensibility to narcotic influences. Geotropism is especially easy to check, even by doses which cause an increase of heliotropic sensibility. The autotropisms, too, are considerably more difficult to check by narcotics than geotropism. . . ."

Dr. Heilbronn concludes with the observation that since in the lowest forms of life, in the higher plant-forms, and in the most highly organized organisms that exist sensibility to external stimuli is decreased by the same narcotic agents, this constitutes an argument in favor of the view that there is an essential similarity in the living substance of all organisms, and we may conclude therefrom that the primitive signs of sensibility to external stimuli which we find at the bottom of the world of organisms bear an intimate relationship to the complicated nervous reactions of modern man.

The Roosevelt-Rondon Scientific Expedition—II*

Its Movements in South America and Some of Its Zoological Achievements

By L. E. Miller, Mammalogist of the Expedition

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CAYMONS were particularly plentiful in the Upper Paraguay. Scores of the evil-looking creatures lay on the sand banks, with wide-open mouths and staring glassy eyes. A fringe of trees flanked the water through which we could see the boundless wastes of *pantanals* beyond; troops of black howling monkeys ambled leisurely away as the boat drew near, and a species of curious gray-throated parrakeet was building tremendous nests in the branches; occasionally in the same tree there were two or three nests each several feet in diameter, which the birds were entering and leaving like bees at a hive.

Sao Luis de Cáceres was reached January 15th, and at noon the next day the "Nyoac" weighed anchor again and pointed her nose up-stream. That night we reached a small station known as Porto Campo, and as the river was too shallow to permit the steamer to ascend further, our effects were taken ashore and tents erected for a temporary camp. A few days' hunt at this point resulted in an addition to the collection of tapirs and white lipped peccaries shot by Colonel Roosevelt, besides a goodly amount of smaller material. The preservation of the large specimens was somewhat of a problem as the time at our disposal was wholly inadequate, and there was practically no available native help. All the skinning and preparation was done by Kermit Roosevelt and the writer, although at times valuable assistance was rendered by Mr. Sigg.

January 13th found the expedition aboard a launch (one boatload had preceded us) struggling against the swift current of the Sepotuba. A heavy houseboat full of provisions and luggage was towed alongside and we made slow progress. There is an end to all things of earth however, and the end of our river journey came on January 16th. We had reached Tapirapoan, the furthest outpost on the frontier, and immediately preparations were begun for our long dash across the *chapadao* of Matto Grosso.

Tapirapoan presented a scene of festive gaiety upon the arrival of the expedition at that point. The large, open square around which clustered the low mud-walled huts was decorated with lines of pennants, while the American and Brazilian flags fluttered from tall poles. Flag raising and lowering was always an impressive ceremony; everybody lined up and stood at attention while the banners were solemnly raised or lowered, as the case might be, to the strains of martial music.

A large number of horses, mules and oxen had been gathered from the surrounding country; the army of natives or *camaradas* who were to have charge of them and the impedimenta, had assembled, and the ward-rooms were filled with cases and bags of provisions and equipment. To organize properly a cavalcade of such large proportions required some little time, but within six days of our arrival order had been restored out of chaos and the first detachment of the expedition started. This included all of the Americans, and several Brazilians to whose number Lieutenants João Lyra and Joaquin de Mello Filho had been added. Captain Amilcar was to follow the next day with the remainder of the caravan. This division of the party was absolutely necessary as, on account of the great quantity of men and animals required, the expedition would have been unwieldly if it had attempted to move in one body.

The first day's ride was a short one. Early in the morning the men started to load the pack animals, many of which were apparently fresh from the ranch and had never been broken to work of any kind, so that there was a good deal of confusion at first. But gradually the men became more adept at their work, the mules and oxen quieted down and little squads left the corrals, wound up the trail and disappeared in a cloud of dust. We did not follow until noon. Our mounts were good strong animals; we had both horses and mules, and comfortable saddles were also provided by the Brazilian commission. A four hours' canter through brush and forest-covered country brought us to the Sepotuba again, quite some distance above Tapirapoan, and we crossed the stream on a pontoon ferry made by laying a platform of boards across three dugout canoes. There were a number of new palm-leaf houses on the river bank, so these were used for the night's camp instead of erecting the tents.

Next day we were in the saddle by nine, riding through tall virgin forest with occasional stretches of sandy soil in which only low bushes grew. It was evident as we penetrated farther into the interior that the forest zone was fast disappearing, to be replaced by the vast *chapadao*[12]. The heat was intense; there was no rain, and troublesome insects were lacking. At three o'clock in the afternoon we entered an old clearing. Formerly rice, plantains, mandioca[14] and corn had been cultivated here, but now the place was deserted and overgrown with weeds. Kilometer 52, as the spot was called, had been an important camp of the telegraph commission while work was being prosecuted in that region, but had long since been abandoned.

On January 23d, a 32-kilometer ride took us to the site of an old Indian village, known as Aldeia Queimada. We were adhering closely to the telegraph line, following the wide swathe that had been cleared to protect the wires from falling trees and branches, except when a short detour was desirable to find a better crossing for some small stream. The country was of a gently undulating character, covered with wiry grass and a very sparse growth of stunted, gnarled trees. This vegetation is typical of the *chapadao*. With the exception of a few small deer and a number of birds (woodhewers and jays) there were no evidences of animal life. A clear, cold spring rippled over a pebbly bottom near our night's camp. It was the last stream we should see which discharged its water (via the Sepotuba) into the Rio de la Plata system.

*From the American Museum *Journal*.

[12]*Chapadao:* high, nearly level upland covered with scanty scrubby forest.

[14]Mandioca: also called "manioc," the cassava plant.

Nhambiquara women and children with baskets of vegetables from the fields.

Parecís Indians playing head ball. They show wonderful dexterity in striking with their heads the hollow rubber ball, a foot in diameter.

Parecís Indians returning from the field. They raise large crops of mandioca, corn, sweet potatoes, make clothing, hammocks and various ornamental articles.

Colonel Rondon had employed a number of motor trucks in constructing the telegraph line through this section of the country, several of which were still in serviceable condition. It was therefore decided that a part of the luggage should be sent ahead on the cars as far as the trail permitted, and as there would be a wait of several days while the remainder of the expedition caught up, Mr. Cherrie and I went along to devote to collecting the time thus gained. Doctor Zahm and Mr. Sigg accompanied us. We started two days beyond Aldeia Queimada, from a point called Rio Mandioca. There were three motor trucks, great well-built machines of German make, laden to their fullest capacity with the heaviest and most cumbersome pieces of the baggage. It was a strange sight to see them racing across the uninhabited *chapadao*, at a speed of thirty miles an hour, and frequently through blinding rain and deep mud. One of the cars had a full-blooded Indian mechanician who seemed to be fully initiated into the mysteries of handling an automobile, from gathering up branches and stones with which to fill up the roadway when the broad wheels mired deep in the loose sand, to repairing the engines on the rare occasions when such a procedure was necessary.

We reached the Rio Sacre, beyond which point the trucks could not proceed, on the evening of the 28th. The river is here broken by a fall 150 feet high. As elsewhere in South America, we were constantly reminded of the appalling lack of animal life. During the entire three days required to reach the Rio Sacre we saw only a few rheas, a seriema[15] or two, and a number of deer.

On the morning of the 29th, we crossed the Sacre on a pontoon ferry, and using a number of animals which had been held in readiness there, rode the two leagues to Utiarity, a village of the Parecís Indians; the Rio Papagaio, a clear, swift stream flows past the settlement, and half a mile away dashes over the brink of a precipice 250 feet high.

The Parecís are a small tribe of semi-civilized Indians who live in substantial huts and cultivate large fields of mandioca, corn and sweet potatoes. Some of them wore clothes while many wore only a breech-cloth of their own weaving. They also make hammocks and various articles for ornamental purposes. The youths of the tribe engaged in a curious game of head-ball, using for the purpose a hollow rubber sphere a foot in diameter, which they themselves manufacture. They chose sides and batted the ball back and forth across a line, with their heads. The hands were not used, and they displayed remarkable dexterity and tireless energy at this form of amusement. One evening just before sundown, practically all of the men joined in a sacred dance. For this occasion they were clothed in gaudy red head-bands from which protruded the brilliant feathers of the great blue and yellow macaw; bead neck chains and belts, and anklets made of bunches of curious dry seeds which kept up a continuous rattling sound as the dancers stamped in rhythm with the low, wailing music of reed flutes. They stopped frequently to drink *chicha*,[16] and at intervals they sang the names of their dead warriors and mighty hunters, and called upon them for guidance and assistance.

Utiarity proved to be a profitable collecting place. Many small rodents and a few larger mammals, including a soft-shelled armadillo collected by Colonel Roosevelt, were taken, besides a number of birds. We spent five days in the village (Colonel Roosevelt arrived three days after we did) at the end of which time Doctor Zahm accompanied by Mr. Sigg left the party and started back home. A short time later Mr. Fiala began his homeward trip down the Papagaio and Tapajos.

Utiarity had been the first telegraph station in operation along the new line; the second was on the banks of the Rio Juruena, approximately 100 kilometers away, and it required five days to reach this point. We had been compelled to reduce the amount of our baggage very materially shortly after leaving the Parecís village, as many of the cargo animals had given out on the trail, and the others were weakening perceptibly. Most of the tents were abandoned, and all superfluous clothing was left behind. The equipment for collecting and preserving specimens, unfortunately, had to be reduced also, on account of its weight, so that we retained only a few hundred cartridges and about a dozen traps with which to prosecute the natural history work. This reduction of the impedimenta was unavoidable and affected every member of the party either directly or indirectly. It was one of the several instances where individual interests had to be sacrificed for the good of the whole expedition.

Type of Indian assistant, or camaradas, employed by the expedition.

At Juruena we made the acquaintance of a primitive tribe of Indians who probably represent the lowest type of civilization to be found anywhere on the South American continent. They are known as the Nhambiquara. As we drew up on the river bank they gathered about and stared at the party curiously, but betrayed no hostile feelings. Colonel Rondon had but recently succeeded in establishing amicable relations with them. On his first visit to the country, numbers of his men had been slain by their poisoned arrows, and they had resented his every step into their stronghold; but having been persistently treated with kindness, they have learned to look upon him as a friend, and some of them even appeared to be heartily glad to see him.

In stature the Nhambiquara is short, but well built, and of a very dark brown color. Clothes are absolutely unknown to them, and practically the only ornaments in their possession are strings of beads which they had received from Colonel Rondon. Some of the men have the nose and upper lip pierced and wear pieces of slender bamboo in these perforations. Their huts or *malocas* are rude structures of grass or leaves, and they cultivate small areas of mandioca, but wild fruits, game and wild honey form the principal articles of their diet. Bows six feet tall and made of palm wood, and long bamboo arrows are used both in hunting and in warfare. Frequently hunting parties go on long tramps through the jungle, subsisting entirely on the fruits of their prowess. At night a rude lean-to is built of branches, the game is roasted in a roaring fire and eaten, and then they stretch themselves on the bare ground to sleep.

We remained a day at Juruena to rest and to develop films. The pictures taken by the various members of the party form one of the important records of the expedition, and great care has to be exercised in developing all exposed films promptly or they would be spoiled because of the hot, damp climate.

The country beyond the Juruena is somewhat rolling, but there is no appreciable change in the vegetation. We rode 20 kilometers the first day, camping on the banks of the Rio do Fomiga (February 10th). Next day we travelled but 12 kilometers, reaching the Juruena, a shallow though rapid stream 600 feet wide; the crossing was slow and laborious as there was only a very small *balsa* or ferry. Camp was pitched a league beyond, on the banks of a small stream. Near by were several deserted thatched huts, and the comparatively new graves where three Brazilians, one an army officer, had been buried. They had been slain by the Nhambiquara and buried in an upright position with the head and shoulders protruding above the ground. The following night, on the Rio Primavera we saw two other graves. The two men who had been interred here were slain while asleep in their hammocks. This was the most dangerous part of the whole Nhambiquara country.

Campos Novos was reached February 16th. Formerly the third telegraph station was located here, but it now stands on the Rio Nhambiquara, a league away. We were on the border of the great Cerro de Norte, a vast tract of country comprised of high, broken plateaus or mesas covered with luxuriant grass. Many small streams flowed through deep gorges, and near some of the water courses, tall dense forest grew. The soil is fertile and would produce crops of corn and rice; cattle in great numbers could be reared on the extensive mesas, and the climate is cool and healthful. There are few portions of South America so well suited for colonization by Europeans, but on account of the remote location and the lack of means of communication, it will be several decades before this vast and fruitful region will become inhabited.

After leaving the Cerro de Norte, February 23d, we again entered *chapadao* country; but the wiry grass and stunted trees were gradually being superceded by forest. Occasionally all other vegetation gave way to large areas of wild pineapples. There were many square miles of them, bearing fruit which was small but of delicious flavor.

We added few specimens to the collections after leaving Utiarity. Animal life was not abundant, and the rapid pace at which the expedition was compelled to move left no time for collecting. At José Bonofacio, which was reached February 23d, an interesting rodent, somewhat resembling a gopher, was taken. In order to secure the single example it required a half day's time and assistance of five Nhambiquara. A reward of bunches of coral beads had been offered the Indians if the animal was secured, so they immediately began work with sharpened sticks and with their hands. By noon they had excavated 10 cubic yards of earth and won the prize. The expedition had gone on ahead but was overtaken in the evening.

At a camp named Siete de Setembre the two divisions of the expedition were reunited. Captain Amilcar and his party had arrived a day or two before, and a halt was made to divide the equipment and provisions between what were to be the Dúvida and Gy Paraná parties. The Rio da Dúvida was only 10 kilometers away, and on February 27th we stood on the bridge that spans the river and watched Colonel Roosevelt and his party in seven canoes disappear down the stream. Colonel Roosevelt was accompanied by his son Kermit, Colonel Rondon, Lieutenant Lyra, Mr. Cherrie and Doctor Cajazeira, and fifteen native assistants.

The Gy Paraná party was composed of Captain Amilcar, Lieutenant Mello, a geologist, a taxidermist and myself, besides a number of natives. We traveled

[15]Seriema: a large, long-legged crested bird, probably related to the cranes.

[16]*Chicha:* a fermented drink made from maize or cane sugar.

Nhambiquara women and children.
These people probably represent the lowest type of civilization on the South American continent.

three days longer to reach the Commemoracao. The spot was called Barao de Melgaço, and marked practically the end of the telegraph line. The trip from Tapirapoan to the Commemoracao had required exactly 40 days; the distance is approximately 548 miles. Many of the pack animals were in such poor condition that they had to be shot. It is impossible to say how many had been lost on the way, but the number was very large.

Barao de Melgaço seemed to be the headquarters of annoying insects and disease. Most of the handful of men at work on the telegraph line were ill with fever and beriberi, and there had been twelve deaths just before our arrival.

We had expected to find canoes awaiting us, but as there were none, the men cut down a tree of ample size and began making one. This work, we estimated, would require a month; but after a wait of two weeks a large canoe arrived from down the river.

The time at Barao de Melgaço was profitably if not pleasantly spent. All about the little clearing rose the stately Amazonian forest, providing admirable collecting grounds. Many birds and mammals were taken, all new to the collection. The latter included an undescribable spider monkey and a saki[17] of a new genus.

We started down the Commemoracao March 13th, and traveling rapidly with the current reached the Pimiento Bueno, 80 kilometers below, that night. The junction of the two rivers forms the Gy Paraná.

The Gy Paraná at its very beginning is a mighty river, a thousand yards wide, and day by day as we raced with its swirling torrent we watched its rapid growth until near the mouth it reached a breadth of at least two miles. The country on both banks is heavily forested, and along the upper course is inhabited by a tribe of Indians which had been absolutely unknown. We were the first white men to see them, and they had never seen white men before. In appearance they differed greatly from their neighbors, the Nhambiquara. We met seven, all men, and finally induced them to accept gifts of beads and knives, in return for which they gave us wonderfully decorated arrows six feet tall.

The Gy Paraná abounds in formidable rapids, like many South American rivers, and we had numerous overland portages, the longest being about three miles, around the falls of São Vicente. Insects are abundant, and the whole region is a vast breeding ground for malaria. A number of rubber camps are situated on the lower river, the forests being rich in hevea. We reached Manaos April 10th, having stopped at Calama, a station on the Madeira, for a short period of collecting.

As the Dúvida party had not arrived, I almost immediately left for the Rio Solimoes where several weeks were spent to advantage adding to the collections. Among the large number of specimens collected were agoutis, woolly monkeys, squirrel monkeys, sloths, many small rodents and squirrels, all new to us; and the complete material for a group of hoatzins or lizard-birds was also collected. The collections now numbered about 1,500 birds and about 415 mammals, practically all of species unknown to us, and some of which are no doubt new to science.

Colonel Roosevelt's party reached Manaos the last day of April, but the story of their experiences on the unexplored river is too well known to warrant review.

[17] Saki: a South American monkey with a bushy tail and a ruff of long hair around the face.

Wireless Transmission of Energy—II*

An Explanation of its General Nature and Relationship to Transmission by Wire

By Elihu Thomson

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2050, Page 253, April 17, 1915

LET US suppose that the charge is positive at the top, and necessarily the surface below and surrounding the mast will be negative. Electrostatic lines will extend from the mast, and particularly from the expansion at the top down to the earth's surface in all directions around the antenna, as in the figure. The medium around the antenna will be stressed electrostatically. This would be all, provided the charges were stationary, but the system we are considering is dynamic. The plus charge is replaced by a minus charge at the top, and a current of a high frequency runs up and down the antenna, but so also does this current extend into the sea

Fig. 21A.

radially from the foot of the antenna, replacing the negatively charged area by a positively charged zone, as it were, while the top of the antenna is now negative where it was formerly positive. (Fig. 21a, one side only shown, and Fig. 21b, in plan.)

As this action goes on, however, the zone of charged surface widens, and ether waves are, so to speak, detached from the antenna, and electrostatic lines join now through the air or ether above the successive zones which surround the antenna as great circles or flat rings of the sea surface. A plus area is followed by a minus, a minus by a plus, etc., and to indicate the effect in the space above, we draw lines which follow these areas, extending up into the ether above the surface, but moving away from the antenna with the velocity of light. The moving charges in the sea surface represent radial currents which are in opposite phase at different portions of the sea surface, and spreading at 186,000 miles per second, and these currents necessarily generate magnetism or lines of magnetic force in the medium directly above them. These lines extend around in zones with diminishing intensity upward from the sea surface as the distance from the surface increases. Even within the water itself a similar action, but more restricted, takes place. The charges in the water are connected by electrostatic stress lines, and the compensating magnetic field follows the current, but this "under water" effect does not concern us, as what we work with is the energy conveyed in the shape above the sea, the other not being so easily recoverable.

* Lecture by Prof. Thomson, printed by permission of the National Electric Light Association, New York, after revision, for the SCIENTIFIC AMERICAN SUPPLEMENT, by the author.

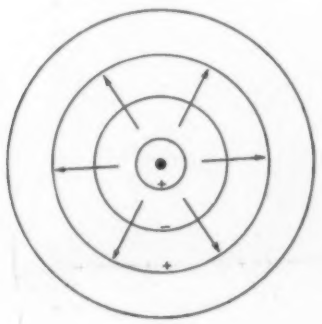


Fig. 21B.

The system as thus far constituted is merely an arrangement for delivering energy in high-frequency waves to the widespread medium around the antenna. There is no selective action whereby it is focused anywhere—it is as a "voice crying in the wilderness." It can be picked up or recognized in any direction by anyone who is within range. If, now, we are to receive signals such as are made by interrupting or disturbing at intervals this system of radiation of energy, as in ordinary telegraphy, we must set up somewhere a receiving apparatus which will enable us to pick up whatever small fraction of the energy reaches it and, if possible, a sufficient fraction of such energy for the recognition of the signals. If the signal can be recognized —no matter how small the fraction of the energy sent out is which we collect at the receiving station—the system succeeds. There is no question of efficient transmission, as there is in the ordinary power-transmission systems. The latter are for the transmission of energy with as little loss as possible, the former for the transmission of signals only.

In the antenna transmission just considered it is assumed that the surface of the earth is, generally speaking, a good electric conductor. The surface of the sea is sufficiently good. Dry land surface, however, is not a good conducting sheet, and even though moist it is generally so irregularly conducting that obliteration of the waves and loss or absorption of the energy must necessarily occur. Obstacles, such as dry rock ranges, may absolutely prevent the waves from passing over them. It must be borne in mind that these waves have no inertia, as such, and that the energy must be guided to its destination by a conducting sheet. This calls to mind the efforts that were made to connect Lynn and Schenectady by a wireless system, but without success. Occasionally signals were received, but in general they were too indistinct to be recognized. It is more than probable that the dry rock ranges of the Berkshires in western Massachusetts were sufficient of an obstacle to prevent the energy of the waves getting across them.

It is also to be questioned whether there may not be another action which interferes with and disturbs the integrity of the waves. It is conceivable that waves may follow a water surface, even around a cape, and that a portion of the energy may take a short cut across the land of the cape. If this be so, the longer course would be around the cape, the shorter course across the land. The wave-lengths would remain the same, and an out-of-phase relation or interference phenomenon would take place to a greater or less extent. It is manifestly necessary that the energy, by whatever course it follows, shall reach the receiving apparatus in phase.

Let us now consider for a moment the conditions at great distances over the earth's surface. At moderate distances from the transmitting antenna the surface may be considered as flat. The conducting sheet guiding the energy is flat or plane, but at great distances the curvature of the earth's surface becomes an important factor. For a time there was a great deal of discussion as to the reason why the energy in the wireless transmission seemed actually to follow the curvature of the earth, instead of going straight away, as in the case of Hertzian or heat and light waves. If the waves had been generated by a large Hertzian oscillator, it would not be possible for them to so follow the earth's curvature, but inasmuch as they are in wireless work produced and, as it were, positioned upon a conducting sheet (the sea surface), then it follows that the energy must be guided by that conducting sheet or surface, regardless of its extent or its curvature. I have never been able to understand why so much discussion has been needed to clear up this point. Wireless waves have no inertia—they follow the course of the charges which produce the stress and of the magnetic field, due to these charges in motion. These charges in motion are the currents in the conducting sheet, which may or may not be curved. In the curved surface of the ocean the zones of charge continually expanding, plus and minus respectively, are still connected by the electrostatic lines above them, and the moving charges still generate the same magnetic field as they traverse radially or outwardly in the curved instead of the plane sheet (Fig. 22),

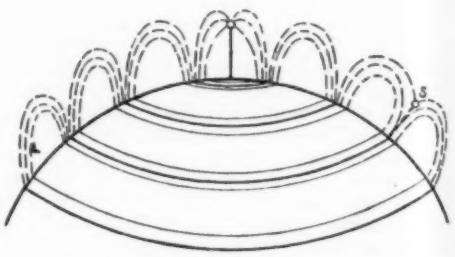


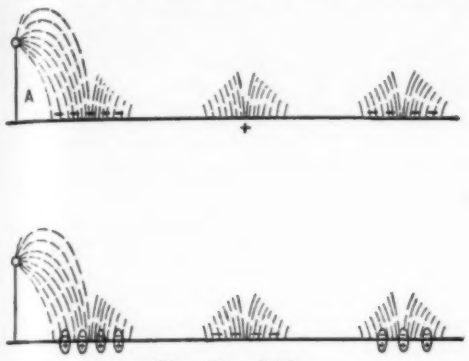
Fig. 22.

and this curved conductor still guides the energy, just as the wire does in ordinary transmission. It would seem, if this is the correct view, that at a distance comparable with that of a quadrant of the earth's circumference the form of the wave would be such as to cause the stress lines to lean backward with respect to the surface, tending to keep their original relation to the transmitting antenna as they were detached therefrom (Fig. 22, at L). This assumes that the velocity of transmission is the same as that of the speed of light, both for the currents in the sea and for the stresses above it.

Marconi's success as a wireless pioneer depended largely upon the choice of a sufficiently sensitive receiver. Two elements are necessary in the receiver. First, a conducting structure which gathers up the energy from the medium, the ether, above the earth's surface. The other element is a sufficiently delicate means for detecting the slightest changes of electrical condition, not only actuated by what little energy is received, but so modifying it that it can operate a signal which can be seen or heard. Usually the receiving ap-

tenna is a vertical conducting mast or cage, like the sending antenna. In fact, the functions of sending and receiving are interchangeably used on the same structure; the same antenna may be at one time used for transmitting and at another time for receiving.

The receiving antenna (Fig. 22) serves to relieve the electrostatic stress in its vicinity, much as a lightning rod may act to relieve cloud to earth stresses. If its direction could be made to follow or be parallel to the actual course of the transmitted lines in the space near it, it would be most effective, and if, further, it could extend sidewise over a considerable extent of the wave front, it would gather up more energy. These conditions, however, can at best be only approximately met. If the receiving antenna were of such a character as to have no oscillation rate of its own (a damped circuit) it would receive energy in a small amount from the transmitting antenna independent of the frequency, but as this would in most cases be far from sufficient, it is desirable to accumulate energy in the receiver from a train of waves at a definite rate. To do this the principle of syntony or tuning is brought in. Everyone is familiar with the two tuning forks, where one is sounded and the other is placed at a distance away. If the two forks are not in harmony, no effect of the one fork on the other follows, but if they are accurately tuned in unison, the sound of one fork at a considerable distance from the other starts the second in vibration and produces an audible sound from it. The second fork is, in fact, a structure particularly well adapted to gather up the energy of the sound waves which reach it, receiving from each wave a small portion of energy and accumulating such energy until the fork itself is brought into palpable vibration. By applying this principle in wireless telegraphy, that is, by causing the rate of vibration or frequency of the electrical waves to be the same in the transmission and in the receiving antennæ systems, constructing both to possess a normal rate as if they were to be electrical tuning forks of the same pitch, the amplitude of the received impulses is so greatly increased that signal strength is reached where otherwise failure would have resulted. The one thing which has characterized the more recent advances in wireless telegraphy has been the accuracy of tuning and the removal of disturbing influences which would interfere with the tuning.



Figs. 23 and 24.

Formerly the transmitting circuit was excited by means which tended to disturb the actual normal rate. If excited inductively, the inducing or primary circuit had a rate of its own, which was apt to interfere with that of the vibrating antenna system. However, what is known as loose coupling (Fig. 20), instead of close coupling (Fig. 19), to the primary or exciting circuit causes such confusion of rates to be nearly negligible if, particularly in the exciting circuit, the current is well damped, as it is termed, or confined to a single brief impulse as far as possible. In such case the antenna circuit, in transmitting, acts as if it were a bell struck with a sudden quick blow, and it vibrates at its own rate without disturbance or interference. At the receiving end (and there may be, of course, many receivers in the space around the transmitting antenna), the "listening-in" process consists in adjusting the rate of vibration of the receiving circuit by variable condensers or inductances, so that the maximum loudness of the received signals is attained. The two systems, transmitting and receiving, are then in tune.

Accuracy of tuning is evidently very important if stations are to be simultaneously transmitting when near together, as only in that way can one station send out energy without interfering with the other; the particular receiver for which the signals are intended being tuned for the particular antenna sending these signals. In spite of the accuracy of tuning, however, high-power stations may, in fact, cause high frequency waves of high potential in all surrounding wire or metal structures if near enough. Burn outs, or even fires, may occur from this cause. Hence, it is desirable that high-power sending stations should be well removed from centers of population where there are electric circuits and electrical apparatus likely to be interfered with or injured.

It may be here pointed out that the limit of potential which is available in wireless transmission is the same as that of long distance transmission by wire and for the same cause. Naturally, if the potential on the sending antenna can be raised, the amount of energy which can be put into the wave impulses will be increased, but there comes a time when an increase of potential on the wires of the antenna gives rise to a corona loss, much as the increase of potential in wire transmission produces a corona loss. The conductors of the system, in such a case, are surrounded by a blue discharge which is even visible at night and which frequently can be heard. When this condition is reached every further increase of potential simply increases the corona loss without adding correspondingly to the energy transmission. Just as in wire transmission it can be avoided by increasing the diameter of the conductors, so in wireless work it could be avoided by constructing the antenna system of hollow tubes with smooth exteriors, and the imagination may be permitted to depict a sending tower of polished metal surmounted by a sphere of similar material and worked at millions of volts. No limit can be set to the amount of energy which might thus be radiated, and no limit as yet can be set to the distance around the earth to which signals might be sent by such means.

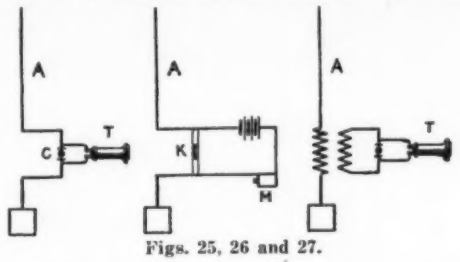
One curious fact which has been developed in the work of wireless signaling is that daylight, especially sunlight, is very detrimental to transmission as compared with the night. That is to say, if the wireless waves are to traverse the sea surface in sunshine, the chance of receiving them in sufficient force to produce signals at great distances is far less than when they are sent at night. It is probable that this difference is not due to any single cause—it may be the effect of a combination of causes. It is a notable fact, too, that this difference between the effectiveness of daylight transmission and night transmission is accentuated at the higher frequencies.

Though the cause is still somewhat obscure, we may venture a suggestion or hypothesis which may have a bearing on the case. Referring to Fig. 23, we have tried to show the condition. The electrostatic field at the water surface at the same instant is, as in Fig. 21, produced in zones around the antenna *A*, spreading with approximately the speed of light. It is well known that under the action of the violet and ultra-violet rays of light any surface having a negative charge will leak its charge and ionize the air near it. This may occur in sunlight over such areas as are marked minus in the figures, and the several minus signs would mark or indicate air ionized and negatively electrified over the negatively charged zones. No action would be expected over the positive areas or zones. But the zones are not stationary; they are widening very rapidly, so that a positive zone or zones takes the place of negative so far as any location is concerned. This may be expressed by saying that the water surface which at one instant was negative and gave out negative ions under the influence of light would, in an exceedingly small fraction of a second and before those ions could get away from electric contact with such surface, become positive and the free ions would now return and neutralize a portion of the positive charge. Thus the negative zones or wave elements would lose part of their charge to ionize air, and the positive waves would be weakened by such negative leak neutralizing them in part. This action, however feeble at each wave, would be continuous over hundreds if not thousands of miles, and continuously damp out the widening system of waves. The effect would be less marked with low-frequency waves, as there would be a proportionately less number of opportunities for this neutralization per second. Besides, with the lower frequency there is more time for the separation of the negative ions to such distance from the water surface that they do not combine with the positive charges, being, as it were, better insulated from them or diffused in the air stratum.

In Fig. 24 an attempt is made to picture this action of attenuation in the presence of light. The negative charges in the air layer, as in Fig. 23, have no positive charges under them, the encircling lines about the + and — signs indicating combination and neutralization.

When the wireless waves reach the receiving antenna, owing to attenuation from spreading or loss as above, they are very feeble. The daylight effect, as pointed out by Fessenden, is much less with the lower frequencies, such as 100,000 per second as compared with 600,000 or 800,000 waves. Consequently there is not the same great difference in strength of signals between night and day work with such lower frequencies. Moreover, frequencies of 100,000 or even 200,000 are capable of being generated directly by high speed high-frequency dynamos with the added advantage that the waves sent out are maintained at their full amplitude and are not, as with waves produced by spark discharges, subject to damping or decay from maximum to zero after a few oscillations.

Whatever the nature of the waves sent out, there is in all cases the need of an exceedingly sensitive apparatus for converting the slight electric effects upon the receiving antenna into signals. The original apparatus of Marconi included the Branly coherer, used by Lodge in Hertzian wave transmission as a detector. It is indicated in Fig. 26 at *K*, with its battery and sounder magnet *M*. The receiving antenna discharge in passing to earth broke down the insulation of the filings of the coherer, so that the local battery current could pass in the circuit, including a magnet *M*, and so record the signal. The liquid barretter of Fessenden, the various



Figs. 25, 26 and 27.

forms of rectifying crystal detectors and magnetic detectors, have been extensively used. Our time does not permit a detailed description. Fig. 25 indicates at *C* a crystal detector rectifying the impulses from antenna *A* so as to work a high-resistance telephone receiver *T*, to which the operator listens. Fig. 27 shows the same apparatus, but connected inductively to the antenna circuit by a transformer.

Fessenden found that if the succession of decaying wave trains reaching the telephone *T* was such as to produce a low note, the signals were easily drowned by extraneous noises or induced effects. He found that the human ear reached a maximum of sensitiveness at about 900 waves of sound per second, so that the signals were heard distinctly when otherwise they would have been missed. This is the meaning of the substitution of dynamos of about 500 cycles for exciting the wireless antenna in place of the ordinary machines of lower frequency.

The problem of wireless telephony has attracted attention for a number of years past. I well remember witnessing some of the earlier work of Fessenden in this fascinating field, in which he was pioneer. The wireless telephone speech was free from all disturbing noises and interferences so common on ordinary telephone lines. Briefly, such telephony depends on the ability to control the voice waves and vary in accordance therewith the energy given out by the transmitting antenna and to do this with a fairly large output of energy.

By employing a method I described about 1892, it is possible to generate a continuous wave train by shunting a direct current arc with a capacity (condenser) in series with an inductance, the frequency rate depending on the electrical constants of these parts of the apparatus. This system, which was the subject of the United States patent taken out by me in the early nineties, has been variously called the Duddell singing arc, or later the Poulsen arc. Poulsen employed it with modifications in his system of wireless telephony. Long before this work of Poulsen, Fessenden had used a high-frequency dynamo for securing the continuous train needed. A suitable microphone transmitter was made to so alter the relations of the waves in transmitting and receiving antennæ, that voice waves could be received in an ordinary telephone connected with the receiving antenna system.

Much progress has been made in this department of wireless work, and such telephony between Europe and America may yet become practicable. Methods are being worked out whereby it may be possible to mold outputs of many kilowatts of energy so as to have them vary with the voice waves, and when this is done many problems, the solution of which now seems remote, may become solved and the results prove of great practical value. It was not, however, my intention to devote time to these later researches, but to endeavor to present to the mind's eye a view of the nature of wireless transmission which should show the similarities to ordinary transmission by wire and also the differences. Furthermore, I hope I have shown it to be evident that future transmission of energy at high efficiencies will still demand the wire core for guiding that energy to its destination.

Metric System in the British Pharmacopœia.—It is announced in the U. S. Commerce Reports, as a matter of interest to exporters of drugs and chemicals, that Great Britain has adopted the metric system in the new British Pharmacopœia, thus conforming to the usage of other countries.

NEW BOOKS, ETC.

EUGENICS RECORD OFFICE. Bulletin No. 10A. Report of the Committee to Study and to Report on the Best Practical Means of Cutting off the Defective Germ-plasm in the American Population. I. The Scope of the Committee's Work. By Harry H. Laughlin, Secretary of the Committee. Cold Spring Harbor, Long Island, New York. February, 1914.

EUGENICS RECORD OFFICE. Bulletin No. 10B. II. The Legal, Legislative, and Administrative Aspects of Sterilization. By Harry H. Laughlin. Cold Spring Harbor, Long Island, New York. February 14, 1914.

EUGENICS RECORD OFFICE. Bulletin No. 11. Reply to the Criticism of Recent American Work by Dr. Heron of the Galton Laboratory. By C. B. Davenport and A. J. Rosanoff. A Discussion of the Methods and Results of Dr. Heron's Critique. By C. B. Davenport.—Mendelism and Neuropathic Heredity. A Reply to Some of Dr. David Heron's Criticism of Recent American Work. By A. J. Rosanoff, M.D. Reprinted from American Journal of Insanity, January, 1914. Cold Spring Harbor, February, 1914.

Before any effective plan can be devised to cut off the supply of defectives, it is obviously necessary to make a series of preliminary studies which will cover the fields of medicine, physiology, surgery, biology, anthropology, psychiatry, psychology, morals and ethics, criminology, sociology, political economy, statistics, law, history, public affairs, etc. Naturally, all these studies have not as yet been made, and before they are made it would certainly be unwise either biologically or sociologically to advocate restrictive measures. The monograph is one which ought to be in the hands of Congressmen and Assemblymen; for sooner or later our legislators will be called upon to consider the problem of restraining the propagation of our defective classes.

In "The Legal, Legislative, and Administrative Aspects of Legislation" Mr. Laughlin has analyzed existing laws, bills vetoed, and bills introduced but not passed, litigation and legal opinion, working out of existing laws, criticism of existing laws, a model law, and calculations on the working out of a proposed programme. The whole is a valuable compendium, which ought to serve as a practical guide in framing suitable legislation for handling the problem of the hereditary unfit.

Dr. Heron's criticism of the eugenic work which has been done at Cold Spring Harbor has received such wide publicity and has thrown so much discredit on Dr. Davenport's investigations, that it was unquestionably wise on the part of the Cold Spring Harbor station to issue its reply to Dr. Heron's criticism of recent American work. The circulation of this reply will do much to remove the impression created by Dr. Heron's strictures, and to reassure those supporters of the eugenic movement who believe that Dr. Davenport and his associates are worthy of every confidence. It is impossible in the brief space at our command to comment upon the contentions of Dr. Heron and the replies made thereto by Drs Davenport and Rosanoff. Suffice it to say that anyone who takes the trouble to read the documents which Drs. Davenport and Rosanoff have prepared will be satisfied that the Mendelian method offers decided advantages over the statistical method, and that in the hands of Dr. Davenport and his associates it has thrown a flood of light upon the problem of heredity, which would certainly have not been the case had the statistical method alone been employed.

DIE ANGEWANDTE CHEMIE IN DER LUFTFAHRT. Von Dr. Géza Austerweil. München und Berlin: Verlag von R. Oldenbourg, 1914.

This excellent monograph discusses the chemistry of balloon and aeroplane fabrics. So far as we are aware, it is the only work on the subject to be had in any language. There are probably not more than half a dozen manufacturers in the whole world who are producing aeronautic fabrics. Hence the difficulty of obtaining anything like accurate scientific data on their methods is all but insuperable. Dr. Austerweil has performed a notable service in collecting together data which must prove invaluable to the industry. After discussing the historical development of gas envelopes and methods of inflating them, he passes to an exposition of the various materials which can be used in making balloon fabrics, such as gold beaters skin, fibrous materials, paper, silks, cottons, linens, ramie, etc. The succeeding chapters are devoted to the chemical effect of gases upon balloon envelopes and the permeability of envelopes to gases. The various varnishes, rubber compounds and the like which are used to secure gas tightness are admirably discussed. The second portion of the book is devoted to the manufacture of aeroplane fabrics. Different factors must of course here be considered. Strength rather than impermeability is sought, and accordingly the author points out how strength can be obtained by proper weaving and other methods. Taken all in all, this is one of the most valuable books which has appeared in the admirable series on aeronautics which the student of aeronautics has reason to be thankful that the house of Oldenbourg is publishing.

THE PANAMA CANAL. Comprising Its History and Construction, and Its Relation to the Navy, International Law and Commerce. By Reuben E. Bakenhus, S.B., Corps of Civil Engineers, United States Navy; Harry S. Knapp, Captain United States Navy, and Emory R. Johnson, Ph.D., Sc.D., Special Commissioner on Panama Canal Traffic and Tolls, 1911-1913. New York: John Wiley & Sons, Inc., 1915. 8vo.; 256 pp.; with maps and illustrations. Price, $2.50 net.

This history and description of the great Canal is so authoritative as to be to all intents and purposes official. It avoids mere impressionistic effects, but it marshalls the facts in so close and comprehensive a manner as to fill a distinct need in the general literature of the undertaking. Part 1 presents the early history of the enterprise, proceeding to France's contribution and the transfer of control to the United States. Part 2 takes up the route, the design and the construction. Part 3 deals with the sanitary problem and how it was met, and gives the cost of the work and the elements of its success. In Part 4 we study the effect of the Canal upon the navy. Part 5 discusses international law in its bearing upon the enterprise, and gives the text of the three treaties. Part 6 is a masterly summary of the Canal's commercial significance, specifically stating the times and distances saved, making a forecast of the probable traffic, and considering the effect upon transcontinental railroad and water-carriage rates.

CALIFORNIA, ROMANTIC AND BEAUTIFUL. By George Wharton James. Boston: The Page Company, 1915. 8vo.; 433 pp.; with a map and 72 plates. Price, $3.50 net.

With its gold and blue binding and its many illustrations in the beauty of natural coloring, this is essentially a book for the library table. That it should attract only the casual glances such volumes are generally fated to would be a great pity. For it is as shrewd and keen as it is astoundingly many-sided. It of course gives us the old missions, the Indians, the recreations and the festivals. But it describes for us, too, Californian industries, the country's increasing influence down the years upon poets and artists and architects, and its bountiful offerings to the pleasure seeker, the health seeker, the sportsman and the automobilist. This much is promised in its lengthy sub-title, and that promise is amply fulfilled in the text. No dreary platitudes are suffered to intrude, but occasional sparkles of humor light its pages. Trees, lakes, waterfalls and mountains are panoramically displayed, and these wonders of nature are admirably balanced by the accomplishments of man. Certainly after assimilating Mr. Wharton's work, one can have little sympathy with the twelve benighted individuals who placarded a tree in the Yosemite Valley with the scroll "We are a band of disappointed pleasure seekers"—and who had the temerity to sign thereto their undistinguished names.

PATTERSON'S AMERICAN EDUCATIONAL DIRECTORY. Vol. XI. Compiled and Edited by Homer L. Patterson, President American Educational Company. New York: American Educational Company, 1914. 8vo.; 804 pp. Price, $5.

The main classification is geographical, and contains a full list of schools and colleges, with information as to their kind, the class of students admitted, their religious denomination, the year of establishment, their heads, and public school officials. A second classification arranges all schools according to kind. The complete alphabetical index makes possible an instant reference to any institution.

GEOMETRY OF FOUR DIMENSIONS. By Henry Parker Manning, Ph.D. New York: The Macmillan Company, 1914. 8vo.; 348 pp.; with diagrams. Price, $2 net.

This work brings together a wealth of references, many of them relating to facts hitherto not readily accessible. The early part of the nineteenth century saw the rise of this distinctly modern branch of mathematics. Most of the ancient writers, with the possible exception of Ptolemy, spoke of the four-dimensional concept as "against nature," "a monster in nature, less possible than the chimæra or centaure." Later, there comes a suggestion that Time constitutes a fourth dimension. We have found that the now indispensable concept of the higher dimensions furnishes—to quote the author—"concise terms and expressions," and by its concrete excogitations enables us "to grasp the meanings of complicated formulæ and intricate relations." Perhaps its greatest advantage is in imparting a very real understanding of the science of geometry itself, by furnishing proofs of theorems in three dimensions and enabling us to rest more upon reasoning and less upon intuition, at the same time developing both intuition and imagination. The method employed by the author is exclusively synthetic, and is presented in popular text-book style.

THE SCIENCE AND PRACTICE OF MANAGEMENT. By A. Hamilton Church. New York: The Engineering Magazine Company, 1914. 8vo.; 535 pp.; with diagrams in colors. Price, $2.

The author has with a commendable degree of success followed Ostwald's principle of arranging known facts in the best possible order and bringing out the relations between them as closely as possible. Only Ostwald had particular reference to chemistry, while the author's chosen field is industrial management. He assigns to this science two basic elements, the Determinative, or policy-planning in both manufacturing and distributive aspects, and the Administrative, which takes care that the policy has adequate expression in operation. He admits the prematurity of at present seeking to reduce the determinative element to a body of principles, and restricts his research to the secondary element, and to but one division of that, namely, manufacturing. Here he treats of five great organic functions, Design, Equipment, Control, Comparison, and Operation. Ripe experience combined with the closest application has gone into the making of this book, which constitutes a valuable addition to the Works Management Library.

OCEAN TRAFFIC AND TRADE. By B. Olney Hough. Chicago: LaSalle Extension University, 1914. 8vo.; 432 pp.

Although the arrangement is that of a text-book, with test questions following each section, this volume is equally well adapted for general reading. The commerce of the port of New York for 1912 was more than four times the commerce of the entire United States fifty years ago. In fact, our foreign commerce now comfortably exceeds the enormous total of two billion dollars. The author, who is editor of the *American Exporter*, compares the various services of our ocean carriers, describes shipping terms and documents, and deals with our shipping facilities, our seaports, our routes, and our charters and freight rates. He describes the method of handling import and export shipments, reviews the rise and progress of marine insurance, and sketches our maritime policy. There are chapters on shipping profits, on acquiring and developing foreign trade, and on credits and collections. The volume carries a large folding map of the world's steamship routes. Altogether the treatise marks another creditable achievement of the LaSalle Extension University, which aims to forward home study under expert guidance.

GENERAL SCIENCE. By Otis William Caldwell, Ph.D., and William Lewis Eikenberry, B.S. New York: Ginn & Co., 1914. 12mo.; 308 pp.; illustrated. Price, $1 net.

"General Science" is a text-book thoroughly modern in treatment and arrangement. Deploring the neglect of the science course by the school, and of the conflict of opinion where such courses are nominally in the curriculum, the authors offer their contribution as an already successful experiment conceived in the scientific spirit and elaborated through actual experience.

THE SPELL OF JAPAN. By Isabel Anderson. Boston: The Page Company, 1914. 8vo.; 396 pp.; illustrated. Price, cloth, $2.50 net; three-quarter morocco, $5 net.

Mrs. Anderson quotes the preamble of the Japanese narrator, "The Rustic and Stupid Wife is loth to give to the Honourable and Wise Reader these few poor notes." This sentiment certainly can not apply to her charmingly sympathetic sketches of the New Japan. To an impressionable temperament she adds a felicity of expression that results in giving us a "personally-conducted" tour of this incomparable country of islands, this land of the million swords. Its woodcarvings and lacquers, its dream gardens, its rice fields, and its brooding, slant-eyed Buddhas, all glow before us in their magic atmosphere. Its peoples pursue for us their curious occupations, celebrate their festivals, and bury their dead. The author's position as wife of the American ambassador under President Taft's administration gave her unusual opportunities that have been taken advantage of in unusual degree. It is sufficient praise to say that the resulting volume is one of the best of the Spell Series, and the attractiveness of the text is augmented by lavish illustration in duogravure and in color.

THE TONSILS AND THE VOICE. In Science, Surgery, Speech and Song. By Richard B. Faulkner, M.D. (Columbia University). Pittsburgh, Penn.: The Blanchard Company. 12mo.; 400 pp.; illustrated. Price, $2.

To cut, or not to cut—that is the vexed question of the tonsils. They are useless and troublesome appendages; they have a distinct physiological function; they have no function, physiologic, biologic, chemical or phonetic; they are the origin of phagocytes that deal with deleterious substances taken into the mouth; their enucleation is followed by improved breathing and lessened liability to sore throat; they are necessary to the acoustics of the voice and accessory to the individual "*timbre de la voix*." These varying opinions come from the pens of equally high authorities and at once indicate the difficulty of the problem to be solved. Lamperti, Shakespeare, Nordica, Lehmann, Sir Charles Santley, and a host of other teachers, singers, and physicians state in this work their experiences and their positions. The anatomy and physiology of the tonsil is lucidly dealt with; a chapter on the science of the vocal art throws many sidelights upon important phases of the subject; and some sane advice is embodied in the chapters on hygiene of the faucial tonsil and the principles of treatment. It is a work everyone should read, and one that vocalists will find particularly beneficial.

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